MINERALS AND METALS SECTOR
SECTEUR DES MINÉRAUX ET DES MÉTAUX

1998 CANADIAN MINERALS YEARBOOK

REVIEW AND OUTLOOK

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Preface

Each year, the Minerals and Metals Sector of Natural Resources Canada undertakes a comprehensive review of developments in the mineral industry and publishes the results as the *Canadian Minerals Yearbook*. This publication forms a continuing record from year to year, with this edition reporting on the activities of the industry during 1998.

The main focus of this publication is the non-fuel mineral industry, together with coal and uranium, although all mineral fuels are normally included when the total value of Canada's mineral production is reported. The Yearbook includes chapters devoted to each major mineral commodity. The subject matter spans all stages of mineral industry activity from geoscience and exploration, through mining and processing, to markets and consumption. Although domestic matters receive the greatest attention in each chapter, international developments may also be reviewed because of the global nature of the mineral industry and the significant impact that such developments could have on the Canadian industry.

The Yearbook's first chapter, entitled "General Review," highlights the importance of the industry in the context of the Canadian economy. In 1998, the non-fuel mineral industry accounted for approximately 2.6% of total national employment, 3.7% of Canada's Gross Domestic Product, and 15.2% of Canada's total domestic exports. The General Review is followed by chapters that focus on the Canadian scene with reviews on mine reserves and recent production decisions; mineral exploration and discoveries; and mine openings and closings. Chapters that detail Canada's global mining presence abroad and outline major bilateral and multilateral developments on the international scene are also included.

The 20 commodity reviews in this year's edition feature economic and policy developments and data specific to each commodity in respect of markets, prices, production, trade and consumption. These commodity chapters also provide an outlook of the industry's future position.

The Statistical Report at the end of the Yearbook is comprised of a comprehensive set of approximately 60 tables that provide a detailed statistical overview of the mineral industry. These tables are grouped according to the following topics: production; trade; consumption; prices; principal statistics; employment, salaries and wages; mining and exploration; transportation; and investment and finance. Although the tables focus on the most recent data available, many of the tables also include historical statistics covering previous years.

The basic statistics on Canada's mineral and metal production, trade and consumption were collected by the Minerals and Mining Statistics Division of Natural Resources Canada, or by Statistics Canada, unless otherwise noted. Market quotations were taken mainly from published marketing reports. Corporate data presented in the various chapters of this Yearbook were obtained by the authors directly from company officials through surveys or correspondence, or were taken from annual reports. Natural Resources Canada is grateful to everyone who has contributed information used in the preparation of this publication.

Additional copies of the 1998 Yearbook may be purchased from the Geological Survey of Canada Bookstore (telephone: (613) 995-4342 or e-mail gsc_bookstore@gsc.nrcan.gc.ca) and local booksellers. Previous editions of the *Canadian Minerals Yearbook* have been deposited in various libraries across Canada.

For more information on the products and services available from the Minerals and Metals Sector, visit our web site at http://www.nrcan.gc.ca/mms, or contact us at:

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Note: Previous and current commodity reviews prepared by the Minerals and Metals Sector are also available on our web site at:

http://www.nrcan.gc.ca/mms/cmy/index_e.html

Updates will be posted as they become available.

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Note to Readers

The intent of this publication is to provide general information and to elicit discussion. It is not intended as a reference, guide or suggestion to be used in trading, investment, or other commercial activities. The authors and Natural Resources Canada make no warranty of any kind with respect to the content and accept no liability, either incidental, consequential, financial or otherwise, arising from the use of this publication.

Abbreviations

The reader should note that a number of abbreviations for common units of measurement appear in the text:

ct	carats
ct/t	carats per tonne
ct/y	carats per year
dmt	dry metric tonnes
ft^2	square feet
g	grams
GJ/t	gigajoules per tonne
g/t	grams per tonne
g/y	grams per year
h	hour
ha	hectares
hp	horsepower
kg	kilograms
kgU	kilograms of uranium
km	kilometres
km^2	square kilometres
L	litres
lb	pounds
m	metres
m^2	square metres
Mct	million carats
mg	milligrams
mm	millimetres
Mt	million tonnes or megatonnes
Mt/y	million tonnes per year
MW	megawatts
oz	ounces or troy ounce
ppm	parts per million
st	short tons
t	tonnes
t/d	tonnes per day
t/h	tonnes per hour
t/y	tonnes per year
tU	tonnes of uranium
y	year

General Review

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OVERVIEW

Although major industrialized countries, such as Canada and the United States, continued to experience positive economic growth in 1998, the depressed state of overall global economic and industrial activity impacted negatively on Canada's natural resource sectors, which saw dramatic falls in commodity prices. This was particularly evident in the Canadian mineral industry where operating profits dropped sharply; significant cost cutting, including mine closings and employee layoffs, took place; and exploration activities declined markedly.

Canada's Real Gross Domestic Product (GDP) at market prices rose by 3.1% to $838.3 billion, an increase of $25.2 billion from 1997, but less than the 4.0% growth of 1997 (Figure 1). Interest and inflation rates remained low and employment growth brought the unemployment rate down to 8% by year-end. The Canadian dollar fell nearly 7¢ from the beginning of the year to a low of around 63¢, but hovered around 65¢ against the U.S. dollar for much of the latter part of 1998. This depreciation provided some impetus to Canadian export sales, which increased to $322.3 billion in 1998 from $301.4 billion in 1997.

Preliminary estimates of the value of production for all sectors of the mining and fuel extraction industry indicated a dramatic drop of 12.3% to $44.3 billion in 1998 from $50.4 billion in 1997. Significant declines in world prices for major minerals and metals led to this result with a significant impact on crude oil and natural gas by-products for which prices plummeted in global markets. This was the first decline for the Canadian mineral industry since 1991 when the total value of production fell by 13.7% to $35.2 billion. When fuels are excluded, the value of production for the non-fuel industry declined by 5.2% to $16.5 billion in 1998. Of this amount, the value of metals production fell by 10.7%, while nonmetals increased by 8.3% and structural materials by 2.2%.

The value of minerals and mineral product exports declined to $69.3 billion in 1998, a 5.1% drop compared to 1997. Low commodity prices brought on largely by reduced demand in Asia contributed significantly to the decline. While raw materials and primary products suffered the greatest decreases, the value of fabricated metal product exports actually increased by nearly 15% in 1998 as exports of these products to the booming economy of the United States rose significantly. In spite of the decline in the value of exports and an increase in mineral product imports, the trade surplus for these products stood at a healthy $15.6 billion.

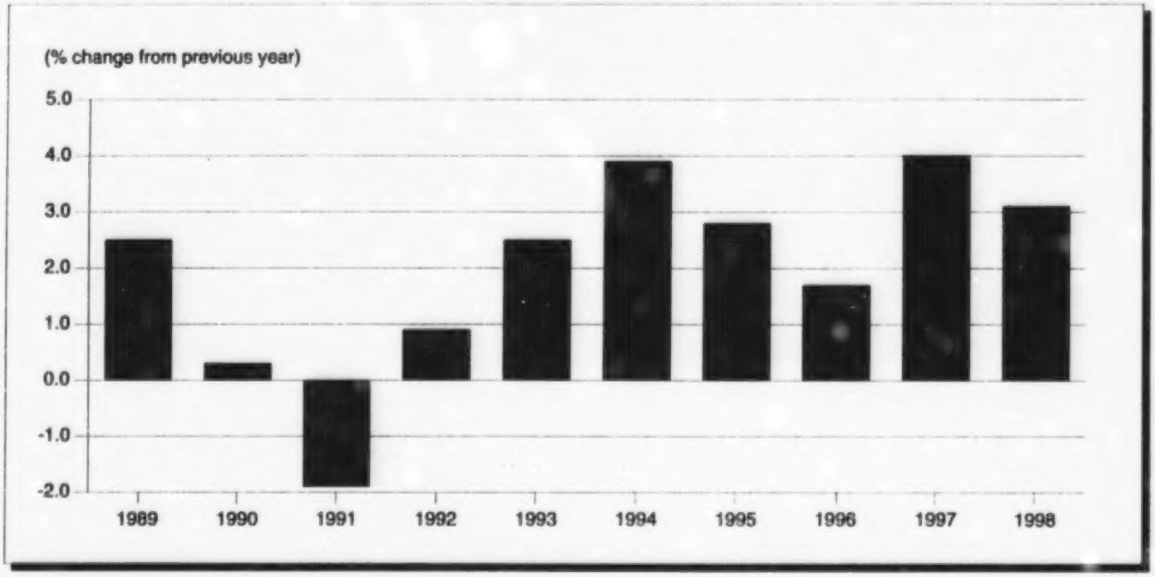
Prices for most major mineral commodities continued to fall and remained weak throughout 1998, largely in response to the Asian financial crisis that surfaced in mid-1997 and the resulting ripple effect that it caused in global markets. In some cases, such as for copper, producers have been slow to adjust and inventories shot up during the year. The impact on nickel was also dramatic as the spot price declined by over 30% during the year. To some degree, the depreciation of the Canadian dollar relative to the U.S. dollar cushioned some of the decline in revenue for Canadian producers. However, operating profits of the Canadian mining sector declined sharply.

Significant developments affecting the Canadian mineral industry in 1998 included:

- falling commodity prices;
- deteriorating balance sheets for many companies;
- the opening of Canada's first diamond mine;
- the impasse that stalled the Voisey's Bay nickel development;
- major capital expenditures in the iron ore industry;
- a continuing decline in exploration activities;
- more mine closings than openings; and
- a decrease in direct mine employment.

It appears that 1999 will see, at best, only a very minor improvement for the Canadian mineral

Figure 1
Canadian Economic Activity, Percent Change in Real GDP, 1989-98
(1992 Prices)



Source: Statistics Canada.

industry. Although the worst seems to be over, the recovery of the Asian economies will be uneven and protracted. In addition, several Latin American countries, notably Brazil, were showing signs of financial stress as 1998 came to a close. Consequently, most major mineral commodity prices, while higher than the levels experienced in 1998, are expected to remain low in 1999. The Bank of England's decision, in May 1999, to sell up to half of its gold reserves and the threat that other central banks may follow suit have had a negative impact on the price of gold, wiping out modest price gains. Reduced industrial activity, primarily in Japan, and advances in steel-making technology requiring less high-grade metallurgical coal have dealt a severe blow to the coal industry. Although most Canadian companies have reduced mining costs, operating profits are low and many have high debt leverage. As well, particularly for nickel, copper and gold, new low-cost additions to mine supply are coming on stream in other countries. These factors will intensify pressure on the ability of higher-cost, older mines to remain operational in 1999.

Based on company spending intentions at the end of 1998, exploration expenditures in 1999 in Canada are expected to decline to less than $500 million from an estimated $600 million in 1998. Low commodity prices have caused many companies to curtail or suspend exploration activity, and fallout from the Bre-X incident still makes some potential investors wary. There are, however, some positive signs. The current downturn in financing is not as deep as the previous one in 1991. In 1998, junior mining companies listed on the Vancouver Stock Exchange raised a total of $300 million, compared to roughly half that amount in 1991. There have also been a few significant mineral discoveries, in Canada and elsewhere, that have revived investor interest.

CANADIAN ECONOMY

Ongoing low and stable inflation rates, low interest rates and increasing employment led to another strong performance by the Canadian economy in 1998. Inflation averaged just 0.9% for the year and in December was at a year-over-year rate of 1%. Interest rates were higher during 1998, but still low by recent historical standards. The Bank of Canada raised its rate by 50 basis points in January and then by 100 points (1%) in August as the Canadian dollar remained under pressure. After that time, three successive 25-point declines brought the Bank of Canada rate to 5.25% in mid-November, where it remained at year-end. Two more 25-basis-point decreases in the spring of 1999 reduced the rate to 4.75%. Consumer confidence and spending remained relatively steady, but were less than the strong performance exhibited in 1997. Canada Mortgage and Housing Corporation announced that housing starts slowed to about 137 400 units, down about 7% from 1997. Housing sales were also off by about 6% at an estimated

311 500 units, even though mortgage rates remained low. Sales of cars and trucks remained flat at just under 1.4 million units, virtually the same as in 1997.

The unemployment rate fell to 8.0% in December from 8.9% in January. Alberta had the lowest rate at 5.7% and Newfoundland the highest at 18.7%. Employment growth rose by an impressive 3.2% as an estimated 449 000 new jobs were created in 1998. Again, as in 1997, the Canadian economy was one of the best performing G7 countries in 1998, trailing only the United States and France in terms of real GDP growth.

On the trade front, total merchandise exports have increased steadily over the last several years, reaching $322.3 billion in 1998. Imports, however, have increased at an even faster pace, thereby reducing Canada's trade surplus to $18.9 billion, down from $23.7 billion in 1997 and $42.0 billion in 1996. As a result of the reduced trade surplus, Canada's overall international current account deficit increased in 1998 to $16.4 billion, up from the 1997 deficit of $14.3 billion. Since 1982, the current account has only had a surplus twice: in 1982 and 1996. The dollar declined significantly against the U.S. dollar as falling prices for mineral, forestry and agricultural commodities had a major impact on Canada's trade balance. At year-end, the dollar was trading at 64.8¢ in U.S. funds, down from a high of about 71¢ earlier in the year. For much of the last half of 1998 and early in 1999, the dollar was trading at about 65¢.

Mineral Industry

National Picture

The mineral industry, excluding the petroleum and natural gas industries, accounted for 3.7%, or $26.5 billion, of Canadian factor cost GDP, the same proportion as in 1997. These proportions can be somewhat misleading, however, in that they are based on 1992 prices. Because current price data by industry are only available up to 1995, they do not reflect commodity prices as they were in 1998. Geographically, the importance of the industry is much more significant on a regional and community basis as, in many parts of Canada, particularly in the North, it provides the major economic stimulus.

In 1998, the total value of production for metals, nonmetals and structural materials fell by 5.2% from $17.5 billion to $16.5 billion. A decline in the value of metals production, caused principally by falling prices, more than offset the gains in the value of nonmetals and structural materials. The value of metals production fell by more than $1.2 billion, or 10.7%, to $10.3 billion as the prices of major commodities, such as nickel and copper, were adversely affected by global supply/demand conditions. A bright spot for the industry was the performance of nonmetals and structural materials, which both experienced gains in 1998, reflecting strong economic conditions in North American markets. Nonmetals increased by $250 million, or 8.3%, to $3.3 billion, and structural materials increased by $63 million, or 2.2%, to more than $2.9 billion.

Prices declined for virtually all mineral commodities in 1998, primarily in reaction to weak global demand conditions, particularly in the Far East where economic growth was negative in major mineral-consuming countries such as Japan and South Korea. Moreover, negative growth was experienced in most Latin American countries and in Eastern Europe, notably Russia. New mine capacity coming on stream for such commodities as nickel and copper also affected prices. Major base-metal prices exhibited a steady downward drift throughout the year, interrupted occasionally by brief, sporadic rallies. In December, copper, aluminum, nickel and zinc spot prices were at their trading lows for the year. For copper, inventories were up by two thirds in 1998 to their highest levels in nearly five years and, at US65.2¢/lb, copper was trading at nearly a 12-year low. Aluminum was down to US55.2¢/lb in December from a high of 68.9¢ in January, although warehouse inventories were down only slightly during the year. Nickel dropped to US$1.69/lb in mid-December, which was down over 35% from its high at the beginning of the year. Nickel inventories finished the year at roughly the same levels as one year earlier. Zinc and lead inventories declined during the year, but prices still fell off. Zinc finished the year at US41.5¢/lb, which was the low for the year, down from its high of US51.8¢/lb in January. Lead bottomed out at US21.7¢/lb in October, down from its high of 27.9¢/lb in April.

For precious metals, gold prices traded in a relatively narrow band, hitting a 19-year low of US$273.40/troy oz in August and closing the year at $287.45/oz, roughly the same as at the beginning of 1998. Jewellery and industrial demand were only off slightly, but uncertainty and speculation continued to prevail throughout the year concerning the intentions of central banks to sell more of their official reserves and a move to delink their currencies with gold reserve backing. The European Union's new central bank, however, indicated that it would back the new Euro currency, which came into being on January 1, 1999, with gold holdings roughly in the same proportion as the national central banks of its member countries. Silver benefited from continued investor interest early in the year, but began to drift as inventories rose and ended the year at US$5.01/oz, down from its high of $7.81/oz. Platinum was down slightly for the year, closing at US$361.50/oz, while palladium was up over 50% to US$334/oz. Both commodities were significantly affected by ongoing production and

export supply uncertainties in Russia. Russia is the world's largest palladium exporter and the second largest platinum exporter. At year-end, cobalt was down over 50% during the year to US$11.50/lb, molybdenum was down over 30% to US$2.60/lb, and uranium was down about one third to US$9.00/lb. For iron ore and coal, where prices are largely determined by benchmark international contracts, iron ore prices were up by nearly 3% whereas metallurgical coal prices were off by nearly 5% and thermal coal by about 8% in 1998. Sulphur prices reflected deteriorated market conditions, dropping about 35% by year-end. Potash prices, on the other hand, were up about 2% (in U.S. dollar terms) during 1998.

With respect to the production of Canada's leading minerals, increases in output volumes in excess of 5% were recorded for copper, nickel, the platinum group, cobalt and peat, whereas declines in excess of 5% were experienced by uranium, lead, asbestos and coal. When prices are factored in, the production values of many commodities fell in 1998, some markedly. Declines in the value of production compared to 1997 were most evident for elemental sulphur, down 35.4%; asbestos, down 22.2%; zinc, down 20.5%; nickel, down 20.1%; lead, down 20.0%; and copper, down 17.4%.

Regionally, four provinces again dominated the value of Canada's non-fuel mineral production during 1998. The value for Ontario decreased by 9.8% to $5.0 billion, Quebec increased very slightly to $3.4 billion, Saskatchewan increased by 5.6% to $2.2 billion, and British Columbia declined by 1.2% to $1.9 billion. When coal is included, Saskatchewan's value of output rises to $2.3 billion and British Columbia's to $2.9 billion. Of the 9 mine openings in 1998, 3 were in British Columbia, 2 in Saskatchewan and 1 in each of Newfoundland, Ontario, Manitoba and the Northwest Territories. Of the 15 closures recorded, 3 were in the Yukon, 3 in Ontario, 2 in each of New Brunswick, British Columbia and the Northwest Territories, and 1 in each of Quebec, Manitoba and Saskatchewan.

Profits by Canadian mining companies fell again in 1998, mainly due to falling commodity prices. For the year, operating profits for the metals sector were down by 44% to $1.4 billion from $2.5 billion for 1997. As well, many companies were forced to write off or write down the value of mining and exploration assets.

Developments in the Canadian Mining Industry

Canada's first diamond mine had its official opening on October 14, 1998. The Ekati diamond mine is operated and 51% owned by BHP Diamonds Inc., a division of The Broken Hill Proprietary Company Limited of Australia. It is owned 29% by Dia Met Minerals Ltd., with 10% owned by each of the two geologists/prospectors who made the original discovery. The mine, located some 300 km northeast of Yellowknife at Lac de Gras in the Northwest Territories, cost US$700 million to bring into production. It is currently forecast to produce between 3.5 million and 4.5 million carats per year from five kimberlite pipes over a 25-year span, with revenues averaging $400 million to $500 million per year, making it one of the 15 largest diamond mines in the world. BHP and Dia Met have agreed to sell 35% of Ekati's production to De Beers and will market the rest themselves. The first Ekati diamonds offered for sale in Antwerp, Belgium, early in 1999 brought about US$125-$130 per carat, excluding the largest stones, which were to be sold later. As well, the company opened a diamond-sorting and valuation facility at Yellowknife and has indicated that it will sell a portion of its rough diamonds to cutting and polishing operations that become established in Canada, initially to those in the Northwest Territories.

A second potential diamond mine in the Northwest Territories continued to make progress towards development in 1998. The proposed Diavik mine, located some 35 km southeast of the Ekati mine, is owned 60% by Diavik Diamond Mines Inc., a wholly owned subsidiary of Rio Tinto plc, and 40% by Aber Resources Ltd. In September 1998, Diavik Diamonds submitted an environmental assessment to the Government of Canada for the proposed mining operation. It is expected that the permitting process will take until late 1999 before a government decision is made. If approved, and if a positive production decision is made, the mine could be in production by the middle of 2003. Work to date has concentrated on the development of four kimberlite pipes for the proposed Diavik mine. The current mineable reserve is estimated at 26 Mt having an average grade of 3.9 ct/t with an estimated value of US$56/ct. Estimates put the capital costs of bringing the mine into production at US$860 million.

Continuing site development of the Voisey's Bay nickel-copper-cobalt deposit in Labrador by Voisey's Bay Nickel Company Limited, a wholly owned subsidiary of Inco Limited, came to a standstill in 1998 as negotiations between the company and the Government of Newfoundland and Labrador broke off. With falling nickel prices, coupled with other negative factors, such as the significant new lateritic nickel capacity coming on stream in Australia at forecast low production costs, Inco took the position that it was now uneconomic for the company to build a smelter refinery complex in Newfoundland to process the Voisey's Bay ore as it had previously agreed to do. The Province responded that, without this processing complex, it would not allow the company to mine and concentrate the ore. Consequently, in July, Inco announced that it had suspended engineering and procurement work on the project. In November, the

Province solidified its position by tabling amendments to its *Mineral Act* to strengthen the provisions to require the processing of ore mined in the province. Although at year-end the impasse continued, informal and confidential talks between the company and the Province were held recently to review how negotiations could be restarted on the key issues identified by the parties. In the meantime, progress has been made on other issues affecting the development of Voisey's Bay. In August 1998, an environmental assessment panel began hearings on the Voisey's Bay project. On April 1, 1999, the panel issued its report and recommendations. The panel recommended that the mine/mill project proceed subject to a number of other separate recommendations. In December 1998, a tentative Land Claims Agreement between the Government of Canada, the Province and the Labrador Inuit Association covering 72 000 km^2 in northern Labrador, which covers the Voisey's Bay area, was announced. However, in early 1999, the Labrador Inuit Association stated that the tentative Lands Claims Agreement would have to be finalized before it would support continuation of the Voisey's Bay project.

In British Columbia, Kemess Mines Inc., a subsidiary of Royal Oak Mines Inc., began production in May from its $480 million porphyry gold-copper Kemess South mine in the Toodoggone River area in the north-central part of the province. The open-pit mine has estimated mineable reserves of 220 Mt averaging 0.018 oz/t gold and 0.224% copper. At year-end, citing continuing low prices for both gold and copper, Royal Oak suspended its debt payments, announcing its intentions to refinance its debt, most of which was incurred to bring the Kemess South property into production. Unfortunately, however, in April 1999, the Ontario Court (General Division) shut down Royal Oak, putting the company into receivership when creditors could not agree on a restructuring deal. The receiver (PricewaterhouseCooper Ltd.) will manage the company's operations until they can be sold to satisfy Royal Oak's $665 million debt. The receivership order also enforces, at least for now, the continuation of operations at the company's three mines: Kemess, Pamour and Giant.

In July, Falconbridge Limited officially opened its Raglan nickel mine on the remote Ungava Peninsula in northern Quebec, although concentrate production began in December 1997. The mining operation involves both open-pit and underground operations. The $486 million project has mineable reserves of 14 Mt, grading 3.17% nickel and 0.88% copper. The nickel-copper concentrate production is trucked to and stored at Deception Bay for shipping. It is expected that a minimum of six shipments per year will be made during the eight-month shipping season.

Luscar Ltd. acquired Manalta Coal Ltd. in a $555 million hostile takeover in September through the tendering by holders of Manalta Coal Income Trust receipts to the Luscar Coal Income Fund Trust (LCFT). The merged company, to be called Luscar Ltd., will be the largest coal company in Canada, owning and operating mines in British Columbia, Alberta and Saskatchewan, and one of the largest in North America. It has a production capacity of about 41 Mt/y for both the export and domestic markets. LCFT is an open-ended trust that receives its income from Luscar Ltd.

In November, the Iron Ore Company of Canada (IOC) announced a $344 million capital expenditure program, raising its six-year total expenditure program begun in 1997 to $1.1 billion. The objective is to increase production capacity in the Labrador Trough area in order to produce higher quality iron ore pellets and to increase production from 11 Mt in 1997 to 17 Mt/y by 2003. This latest announcement features the reactivation of the Sept-Îles pellet plant, which was mothballed in 1982, and includes upgrading equipment at the Labrador City mine, purchasing additional rail equipment, and increasing hydroelectric capacity at its Sainte-Marguerite River generating facility near Sept-Îles. The reactivation of the Sept-Îles pellet plant will enable the company to process the higher-quality concentrates that will be produced at Labrador City. Following a change in the ownership structure in 1997, IOC is now owned 56.1% by North Limited, 25.0% by Mitsubishi Corporation, 12.0% by the Labrador Iron Ore Royalty Income Fund, and 6.9% by Dofasco Inc.

Government and Industry Initiatives

Over the 18-month period ending in early 1999, the Canadian government, through Natural Resources Canada (NRCan), in conjunction with provincial governments and the mineral industry, undertook a wide variety of activities to promote and support Canada's minerals and metals industry and the mining-related equipment and service sector. These activities included: a ministerial-led mission to Latin America (Argentina, Chile and Peru); ministerial participation in the annual Mines Ministers of the Americas Conference (Argentina); a ministerial visit to Russia, the Ukraine and Kazakstan; and deputy ministerial involvement in two investment missions and the Canada: A Window on Global Mining - World-Class Technology and Investment Prospects Conference held in Tokyo, Japan. In addition, NRCan officials, at seminars and conferences around the world and in Canada, have promoted Canada's geological potential and Canadian mineral properties, highlighted the competitiveness of Canada's minerals and metals industry, showcased new Canadian advances in mining, mineral processing and related technologies, and demonstrated to investors that Canada can supply a full range of equipment and services to the world's mining community. Also, the Canadian government is helping small gold mining companies work more efficiently. On May 12, 1999, the Minister of NRCan

officially announced increased funding of $2.5 million over three years for its Canada Centre for Mineral and Energy Technology (CANMET). The funding will be used at the experimental mine facility in Val-d'Or to research innovative methods to automate the extraction of gold from narrow veins.

In December 1997, Canada signed The Kyoto Protocol, or the United Nations Framework Convention on Climate Change, to reduce greenhouse gas emissions. Under this international agreement, Canada will reduce its emissions of carbon dioxide, nitrous oxide, and methane by 6% below 1990 levels by 2012. Levels of hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride will be reduced by 6% below 1995 levels by 2012. In order to develop a national implementation strategy, 14 sector groupings or tables were established by the federal government to bring stakeholders together to make recommendations on how to achieve Canada's commitment by 2012. The Canadian minerals and metals sector, which is part of the Industry Table, began deliberations in 1998. A final report of this Table, with its recommendations, is expected by the end of 1999.

New policy initiatives affecting the mineral industry were announced by several provinces and territories in 1998. In Newfoundland, *The Mineral Act* and *The Quarry Materials Act* were amended to define dimensional stone as a mineral with land tenure administrated under *The Mineral Act*. In Quebec, new tax measures under the *Taxation Act* were introduced to further stimulate exploration in the Near North and Far North areas of the province by adding another 25% to the existing tax deduction for exploration work carried out in these two regions. In British Columbia, four new initiatives were introduced: the *Mining Rights Amendment Act*, which recognizes the right to mine and assures access to mineral tenures, the right to compensation when tenures are expropriated for parks, and timely permitting; the *Mineral Exploration Code*, which creates a one-agency window for permit approvals and applies environmental protection standards designed specifically for exploration; the creation of the position of Mining Advocate; and the introduction of a refundable Mineral Exploration Tax Credit worth up to $9 million annually. As well, the mine allowance that provides a one-third gross-up of capital costs for new mines in British Columbia for mineral tax purposes was extended to all new mines that begin production before January 1, 2010, rather than 2000.

The Mining Innovation, Rehabilitation, and Applied Research Corporation (MIRARCo) was established in April to promote mining innovation and to provide a bridge between knowledge providers and knowledge users. The non-profit corporation is a collaboration between Laurentian University and the private and public sectors. Start-up funding was provided by the Northern Ontario Heritage Fund Corporation, the Federal Economic Development Initiative in Northern Ontario, the Sudbury Regional Development Corporation, the Ontario Research and Development Challenge Fund, Human Resources Development Canada, and Laurentian University. MIRARCo, which consists of several mining research centres and a mining innovation and development group, will attempt to facilitate the transfer of mining-related research to commercial applications by fostering partnerships between technology providers, research and development organizations, service providers, and industrial users.

Established principally in response to the 1997 Bre-X incident, and the resulting loss in investor confidence in the mineral industry, the Mining Standards Task Force of the Toronto Stock Exchange (TSE) and the Ontario Securities Commission (OSC) issued its interim report in June 1998. After gathering comments, the Task Force, which also included members from the mining industry and the financial services sector, released the final report in early 1999. A major recommendation is that companies should be required to have a "Qualified Person" who would be responsible for scientific and technical matters, including the release of all mineral exploration information. Also, it is recommended that companies follow "best practice" operational guidelines. Other important recommendations relate to brokerage houses' behaviour and the need to improve market disclosure and transparency. Similar recommendations were also announced in early 1999 by the Study Committee on the Financing of the Quebec Mining Industry, which was established in 1997 to investigate exploration disclosure standards.

An overview report, prepared by a government-industry task force on federal-provincial/territorial regulatory reform was presented to Canadian mines ministers at their 55th annual meeting held in Calgary, Alberta, in July. This report focused on federal environmental regulations and provincial and territorial mining and environmental regulations that affect exploration, development, mining, and mine closure, as well as the relationship between relevant provincial/territorial and federal environmental regulations and related decision-making processes. The results of this review indicated a need for: increased efficiency and effectiveness of regulations, the administration of regulations and decision-making processes; better coordination and cooperation within and between governments and interested stakeholders; better coordination within and between jurisdictions; clarification of responsibilities and requirements; relevant, easily accessible information; and greater transparency in decision-making processes. Work in these areas by the respective jurisdictions and stakeholder organizations will continue with progress to be reported at the 56th Mines Ministers' Conference, held in Charlottetown, Prince Edward Island, in September 1999.

The Report of the Ontario Lands for Life Round Tables was presented to the Government of Ontario in October. The purpose of the Lands for Life program was to investigate and address the best uses of 39 million ha of the province's Crown Land resources. Three Round Tables consulted with individuals and groups during much of 1998. The Report contains 242 recommendations with a principal recommendation being that the Crown Land in question should be assigned to one of seven land-use designations ranging from new provincial parks to general use areas. Following a period for comments and reaction to the Report, the Government of Ontario announced its decision to accept 98% of the Round Table's recommendations on March 29, 1999, under the banner *Ontario's Living Legacy*. The province's Living Legacy fulfills a key goal of the Lands for Life process through the completion of a representative system of parks and protected areas totaling 12% of the planning area. Of particular interest to the mining and exploration industries, Ontario's Minister of Northern Development and Mines stated that access for environmentally sensitive mineral exploration is being protected in areas of significant mineral potential in the province, and that it is business as usual for existing claim holders and mining activity already under way.

In October, 17 major mining companies, including 7 Canadian companies, established the International Network on Acid Prevention (INAP). The Canadian member companies are Inco Limited, Placer Dome Inc., Teck Corporation, Noranda Inc., Falconbridge Limited, Barrick Gold Corporation and Rio Algom Limited. INAP plans to promote the sharing of information and technology for the purpose of reducing hazards caused by acids produced at mining operations. Two specific issues that INAP plans to study are improved water and air-flow in waste dumps, and coating acid-generating minerals to prevent oxidation of pyrite.

In December, the Government of Canada passed legislation enacting the international Comprehensive Nuclear Test Ban Treaty, which Canada signed in 1996. This treaty, which bans all nuclear weapons testing in the atmosphere, in the oceans and underground, will affect the mining industry. The legislation requires mandatory reporting of all explosions that involve the detonation of more than the equivalent of 300 t of TNT. The reporting of large mine rockbursts and falls are also covered by the legislation. Following consultations with the provinces, territories and the mining industry, it is expected that Canadian regulations will be put in place in 1999 to ensure the collection and reporting of the necessary information to satisfy the commitments of the Treaty.

Planning continued during 1998 for the establishment of the new territory of Nunavut in Canada's eastern arctic and, on April 1, 1999, the new territory became a reality. Canada's third territory covers approximately 2 million km^2, or about one fifth of Canada's landmass. The Nunavut territorial government has the same status and powers as the current Government of the Northwest Territories, including the administration of mineral activities with the federal Department of Indian Affairs and Northern Development. The Nunavut Lands Claims Agreement, settled in 1993, gave the Inuit title to about 18% of the new territory. Eleven percent of the Inuit land includes land with mineral rights. Nunavut Tunngavik Incorporated has regulatory authority over mining on those Inuit-owned lands on which the Inuit hold the mining rights.

A Statistical Portrait of the Canadian Mineral Industry

The Canadian mineral industry can be characterized by the following four stages of processing activity:

- Stage 1: primary mineral production (mining, including quarries and sand pits, and concentrating)
- Stage 2: metal production (smelting and refining);
- Stage 3: minerals and metals-based semi-fabricated industries; and
- Stage 4: metals fabricating industries.

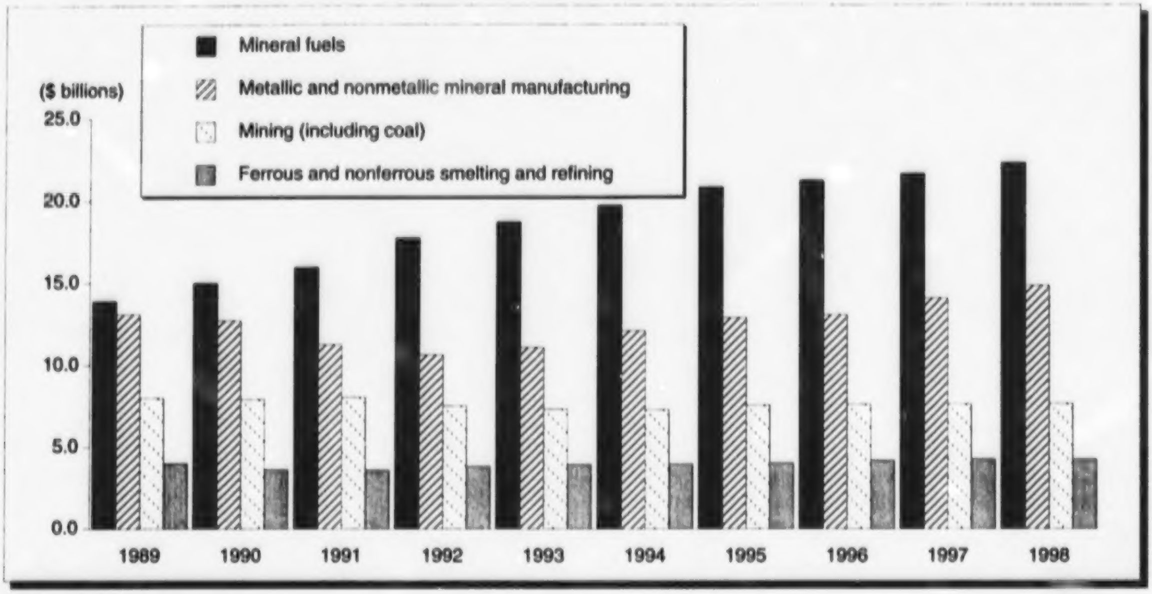
While much of the emphasis of this article focuses on Stage 1 activities (the activities of the mining industry), much of the portrait that follows describes the mineral industry as a whole, providing a more comprehensive picture of the overall importance of the mineral industry to Canada. In the context of this article, the mineral industry should be taken to exclude the extraction and processing of crude petroleum and natural gas, but to include both the coal and uranium mining industries.

GDP of the Mineral Industry

In 1998, the mineral industry, as defined above, contributed $26.5 billion to Canada's total GDP of $717.5 billion. (In this section, all figures are based on GDP at factor cost and at 1992 prices.) The mineral industry, therefore, accounted for 3.7% of the total, the same proportion as in 1997. The 1998 figure for the mineral industry was 3.1% above the 1997 level of $25.7 billion. Because these figures are based on 1992 prices, an increase in the value of production indicates an increase in the volume of goods produced.

The GDP of all four stages of the mineral industry increased in 1998 compared to 1997. In spite of the low commodity prices, the GDP of the combined

Figure 2
Gross Domestic Product at Factor Cost at 1992 Prices, 1989-98



Source: Statistics Canada.

mining and quarry and sand pit industries increased to $7.7 billion, almost 29% of the mineral industry total and slightly higher than 1997's $7.6 billion. The combined GDP of Stages 2, 3 and 4 rose at a greater rate, reaching $18.9 billion, a 4.2% increase over 1997 (Figure 2).

Canadian Mineral Production

Preliminary estimates indicate that the total value of Canadian mineral production (including fuels) declined to $44.3.billion in 1998, a 12.3% decrease from the $50.5 billion recorded in 1997. Both the fuel and non-fuel portions of the total declined – fuels by 16.0%, non-fuels by 5.2% (refer to the table on the following page).

The decline in the value of production in 1998 resulted from a steep drop in the value of mineral fuel production and a significant drop in the value of metal production. These decreases more than offset the increases observed in the value of nonmetals and structural materials.

Table 1 presents commodity-specific production data for Canada's leading minerals. While there were exceptions, most of the major commodities suffered declines in the value of production in 1998 relative to 1997. The value of metal production declined to $10.3 billion from $11.5 billion, a decrease of 10.7%, due mainly to sharp drops in the value of production of zinc (-20.5%), nickel (-20.1%), lead (-20.0%), copper (-17.4%) and gold (-8.1%). Lower prices were the major causes of the declines; the volume of gold produced decreased only 3.1% and the volume of zinc decreased only 3.8%. The volumes of nickel and copper produced actually increased by 11.2% and 6.3%, respectively. The platinum group bucked the trend as both its volume of production (up 22.7%) and value of production (up 66.0%) rose. Short-term concerns about supplies from Russia pushed the price of palladium from US$198/troy oz at the beginning of 1998 to $417/oz in May. The price surge was driven by the lack of imports from Russia, the world's largest producer, during the first four months of 1998. The sharp price increase was only temporary, falling to US$285/oz at the end of May 1998 as Russian shipments began to reach the market. Even so, palladium prices averaged US$290/oz in 1998, significantly higher than the 1997 average of $184/oz.

The value of nonmetal output increased in 1998 by 8.3% to $3.3 billion, almost all of the increase attributable to potash. Potash, the leading mineral in the nonmetals group, accounted for more than half of the total. In 1998, the value of production of potash increased 9.1% to $1.7 billion despite a 2.9% decline in the volume produced. The value of production of chrysotile, the only form of asbestos produced in Canada, declined by 22.2% in 1998, reflecting a 23.8% drop in the volume of chrysotile output. Of the other major nonmetal commodities produced in Canada in 1998, only diamonds and peat registered gains in both the value and volume of production.

CANADIAN MINERAL INDUSTRY VALUE OF PRODUCTION, 1997 AND 1998

	1997r	1998p	Change
	($ millions)		(%)
Metals	11 549.2	10 318.9	-10.7
Nonmetals	3 027.0	3 277.2	8.3
Structural materials	2 885.4	2 948.8	2.2
Total nonfuels	17 461.6	16 544.9	[illegible]
Fuels	33 076.7	27 770.2	-16.0
Total	50 538.3	44 315.1	-12.3

Sources: Natural Resources Canada and Statistics Canada, *Canada's Mineral Production, Preliminary Estimates*, cat. no. 26-202-XIB.
p Preliminary; r Revised.
Note: Numbers may not add to totals due to rounding.

The value of production of structural materials rose 2.2% in 1998 to $2.9 billion, due primarily to cement, which increased its volume of output by 2.3% and its value of output by 6.0%.

Based on the value of output in 1998, the top non-fuel commodities in 1998 were gold ($2.3 billion), copper ($1.7 billion), potash ($1.7 billion), iron ore ($1.6 billion), zinc ($1.5 billion), nickel ($1.4 billion) and cement ($1.1 billion).

Regionally, the picture in 1998 remained much the same as in 1997. Ontario again contributed the largest share of the non-fuel mineral output, accounting for 30.2% of the total value. Quebec contributed 20.8% to Canada's total; Saskatchewan, 13.4%; British Columbia, 11.6%; Newfoundland, 6.1%; Manitoba, 5.5%; and New Brunswick, 5.0%. The remaining provinces and territories accounted for 7.5% of the total.

The value of production of mineral fuels declined sharply in 1998 from $33.1 billion in 1997 to $27.8 billion in 1998, a drop of 16.0%. Of the components within the mineral fuel group, only natural gas experienced an increase in volume of production (up 3.1%) and value (up 4.4%). Lower prices for crude petroleum and natural gas by-products resulted in significant declines in the value of production of these commodities (down 27.2% and 31.1%, respectively), even though the volume produced rose for both. The value of coal production declined by 6.6% and the volume by 5.5%.

Alberta remained Canada's major mineral fuels producer, accounting for 78.1% of the total value in 1998. Alberta also had significant volumes of all the components of the mineral fuels – crude petroleum, coal, natural gas, and natural gas by-products. Other provinces with significant mineral fuel components were British Columbia with 9.3% of Canada's total and Saskatchewan with 8.8%. Crude petroleum production from Hibernia boosted Newfoundland's contribution to Canada's mineral fuel production to 1.6%. The other provinces and territories accounted for the remaining 2.3%.

Employment in the Mineral Industry

Combined employment in the four stages of the mineral industry (including coal mining) is estimated to have reached 367 200 in 1998, 4.1% above the 1997 level of 352 900. The mineral industry thus accounted for 2.6% of the national employment level of 14.3 million.

While total mineral industry employment grew, employment in Stage 1 (metal, nonmetal and coal mining, and quarries and sand pits) declined in 1998 for the third straight year. Stage 1 employment was estimated to be 55 700, a 4.6% decline compared to 1997. Metal mining, nonmetal mining and coal mining all experienced declines in employment in 1998, and the decreases were evident throughout the commodity-specific industries. Mine closures and suspensions due to weak commodity prices, coupled with the necessity to reduce costs and improve efficiencies, led to the declines. Buoyed by the robust North American construction industry, only the structural materials sector experienced an increase in its employment level in 1998 (up 17% to 7800).

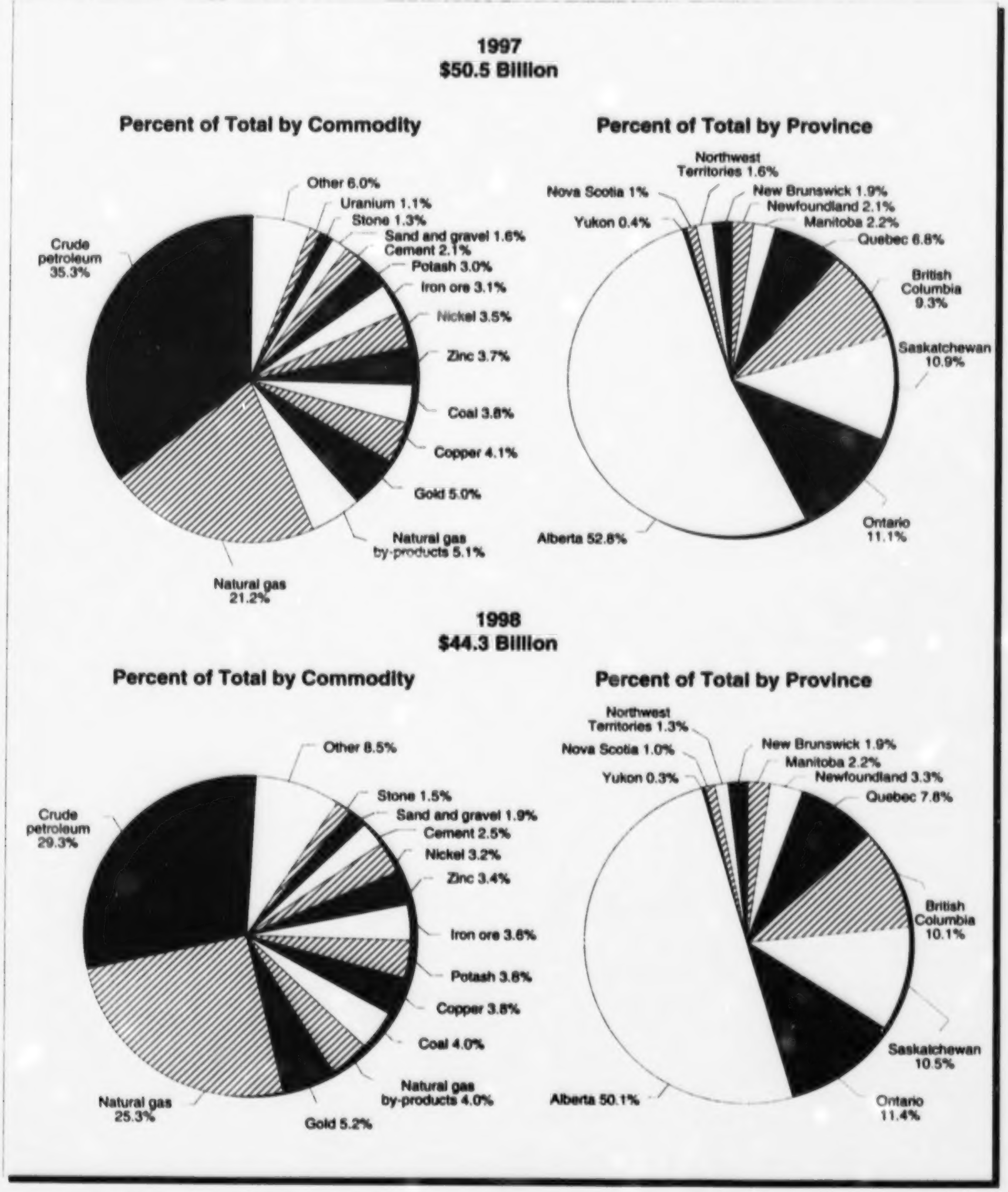
Employment levels for Stages 2, 3 and 4 were all higher in 1998 compared to the previous year. Employment increased in Stage 2 by 1.6% to 59 600, in Stage 3 by 7.9% to 94 100, and in Stage 4 by 6.1% to 157 800. The strong North American economies boosted these sectors.

Reduced activity in Stage 1 affected the level of employment in the sector that provides services incidental to mining and quarrying. This sector provides drilling services, conducts exploration, and provides other services. In 1998, the number employed in this sector declined by more than 10% to about 9700. This figure includes about 2100 in the mining diamond drilling sector. Because there is no establishment-based survey undertaken at this time by either NRCan or Statistics Canada for Services Incidental to Mining, these numbers should be viewed with caution.

Mineral Industry Trade

Canada is one of the world's largest exporters of minerals and metals, and the export of these commodities and more refined mineral products has a significant impact on Canada's overall merchandise balance of trade surplus and, hence, on the national standard of living. The United States is by far the primary recipient of Canada's minerals and mineral product exports, receiving 82.9% of domestic exports in 1998, followed by the European Union (5.8%) and Japan (3.6%). The relative strength of the U.S. economy resulted in an even higher proportion of Canada's

Figure 3
Value of Mineral Production, Percent Shares by Commodity and by Province, 1997 and 1998



Sources: Statistics Canada; Natural Resources Canada.
Notes: The provincial shares may not add to 100% due to rounding. Prince Edward Island's share is excluded as it is too small to be expressed. 1998 data for uranium are confidential and included in "other."

mineral industry exports being directed to the United States. In 1997, the proportion received by the United States was 80.9% (Table 2).

In 1998, for the first time in several years, the value of exports of minerals and mineral products, including fuels, declined, falling 4.7% to $68.1 billion from $71.5 billion in 1997. A decline in the export value of mineral fuels offset gains in the value of metals and metal products, nonmetals and nonmetal products, and structural materials. Metals and metal products contributed more than half (50.8%) to total mineral products exports; mineral fuels, 37.4%; nonmetals, 10.3%; and structural materials, 1.4%. Together these products accounted for 23% of the value of Canada's total domestic merchandise exports.

The total value of metallic minerals and mineral products domestic exports increased to $34.7 billion in 1998, a rise of almost 2% from 1997. Commodities produced in Stages 2 through 4 accounted for the gains. The value of domestic exports of Stage 1 commodities declined by nearly 12% to $3.7 billion. For individual commodities within the total metallic minerals sector, exports rose for iron and steel (13.1%), silver (44.7%) and cobalt (7.5%); they declined for gold (-2.9%), copper (-18.6%), nickel (-10.2%), zinc (-14.7%), uranium (-19.1%) and lead (-15.0%). The value of exports of aluminum and iron ore remained about the same in 1998 as in 1997. Two commodities, iron and steel and aluminum, accounted for almost half of the total value of exports in the metallic minerals and mineral products sector. Other major contributors were gold, copper, nickel, zinc and iron ore.

The value of domestic exports of nonmetallic minerals and mineral products increased in 1998, up 2.6% to $7.0 billion. Gains in the value of exports of potash and potassium compounds (12.9%), glass and glassware (3.6%), salt and sodium compounds (7.8%), peat (11.1%) and abrasives (8.6%) offset declines in nitrogen (-7.1%), sulphur and sulphur compounds (-24.0%), and asbestos (-14.4%). A combination of reduced exports of sulphur to Brazil and Morocco and lower sulphur prices resulted in the significant decrease in the value of sulphur exports. Potash (including potassium products) is the major component in the nonmetals sector, accounting for 28.1% of the value of total nonmetallic exports in 1998.

The value of structural materials domestic exports increased significantly in 1998, rising 13.1% to $959 million, led by the largest component of this group, cement, which was up almost 10%, and miscellaneous structural materials, up 13.1%. Other commodities experiencing gains were granite, limestone flux and other limestone, marble, sand and gravel, and dolomite. The value of exports of clay and clay products, lime and slate declined in 1998.

A significant decline in the value of domestic exports of petroleum (due to sharply lower crude oil prices in 1998) and coal and coke offset an increase in the value of natural gas exports, resulting in a decrease in the value of mineral fuel exports to $25.5 billion, a 14.5% decline from the 1997 level of $29.8 billion. More than half the value of mineral fuel exports is accounted for by petroleum. In 1998, the value of petroleum exports declined by nearly 25% to $13.0 billion. The value of natural gas exports, on the other hand, increased by more than $200 million to $8.9 billion.

The value of imports of mineral products, including fuels, increased by 6.9% from $50.1 billion in 1997 to $53.6 billion in 1998 (Table 3). The value of imports of all the non-fuel sectors rose, which offset decreases in the value of coal and coke products and petroleum. Led by substantial increases in the value of imports of iron and steel and aluminum (up 19.1% and 13.9%, respectively), the value of imports of the metals and metal products sector rose to nearly $39 billion from about $31 billion in 1997. As with exports, iron and steel and aluminum are the two largest components of metal products imports, which comprise 55% of the total. Metallic minerals and products accounted for two thirds of the value of total mineral product imports in 1998, nonmetallic mineral products for 10.4%, structural materials for 2.4%, and mineral fuels for 20.3%. When petroleum and natural gas are excluded, mineral industry imports totaled $43.9 billion, or 14.7% of total merchandise imports in 1998.

As a result of the only slightly increased level of non-fuel mineral exports (but including coal) and significantly higher levels of imports, the balance of trade surplus for these commodities declined to $2.3 billion in 1998 from $7.1 billion in 1997 (Table 4). For the total economy, Canada's merchandise trade surplus declined to a still substantial $19.6 billion in 1998 from $26.2 billion in 1997 as the increased value of imports offset the smaller rise in the value of exports.

Investment by the Mineral Industry

Information on capital spending and exploration expenditures provides a useful indication of market conditions and gives an indication of the views management and investors in the Canadian mining industry hold on future market conditions in relation to present productive capacity.

Exploration Expenditures

Final exploration figures for 1997 show that exploration and deposit appraisal field expenditures totaled $820.2 million compared to $894.8 million in 1996. Preliminary estimates for 1998 indicate that the level of non-fuel exploration and deposit appraisal field expenditures declined sharply to $601.1 million and company spending intentions for 1999 indicate a further decline to $488.6 million. Low gold and base-metal prices, brought on largely by the sharp

downturn in many Asian economies and lower investor interest in mineral exploration activities, are the primary causes for this decreased exploration spending. With the exception of Alberta, all provinces and territories experienced declines in exploration expenditures in 1998. Particularly hard-hit regions were British Columbia, where low gold and copper prices sharply curtailed exploration expenditures, and the Yukon. Diamonds continued to be the driving force behind Alberta's non-fuel mining industry in 1998.

The level of mineral exploration activity is closely linked to mineral commodity prices, so it is not unexpected that estimated exploration expenditures in 1998 and company spending intentions in 1999 have declined. When commodity prices show signs of strength, the mineral exploration industry can be expected to respond. While financing on the Vancouver Stock Exchange (VSE) was down in 1998, the decrease was not as drastic as in previous downturns. According to statistics compiled by Gammah International, a company that tracks mine financing trends, junior companies listed on the VSE raised $300 million in 1998, about double the amount raised in 1991.

A new expenditures survey, launched for 1997 survey data, allows a more extensive analysis of expenditures. When costs for engineering, economic and feasibility studies, environmental protection, and land access are added to the $820.2 million expended for exploration and deposit appraisal, total expenditures rise to $921.0 million.

Capital Investment

Capital expenditures for construction and materials and equipment in the mining and mineral processing industries are expected to reach $6.1 billion in 1999, up from an estimated $5.8 billion in 1998, but down from the $6.7 billion recorded in 1997. While the overall numbers for the mineral industry are relatively strong (1995 and 1996 levels were $4.7 billion and $5.3 billion, respectively), the performance of the component industries (stages) vary markedly. Capital expenditures for the mining and quarrying industry (Stage 1) were estimated to be $2.5 billion in 1998, down 23.4% from the $3.3 billion level in 1997. A further 16.2% decline to $2.2 billion is anticipated for 1999. Reduced demand for mineral commodities and the resultant low prices have, to a significant extent, halted or curtailed mine expansion or new mine development. In contrast, capital investments in the primary metal and nonmetallic mineral semi-fabricating industries (Stages 2 and 3) are expected to increase significantly in 1999 rising 26.9% to $3.2 billion, up from the $2.6 billion recorded in 1997 and the $2.5 billion estimated for 1998, with this sector being buoyed by the strong North American economy. Investments in Stage 4 industries are expected to decline moderately from $796.3 million in 1997 to $758.1 million in 1998 and to $693.2 million in 1999.

In 1997, capital investment in the total economy stood at $157.4 billion. Estimates indicate an increase to slightly above $161 billion for each of 1998 and 1999. In 1997, investments in the mineral industry (Stages 1 to 4) accounted for 4.2% of total capital expenditures in the Canadian economy. The proportion is estimated to decline to 3.6% in 1998 but to rebound slightly to 3.8% in 1999. When repair expenditures to structures, machinery and equipment are included, expenditures in the mining and mineral processing industries totaled $10.9 billion in 1997, the latest year for which repair data are available. The 1997 level represented 5.6% of total capital and repair expenditures within the Canadian economy. This indicates that in 1997 the mineral industry spent relatively more in repairing (rather than adding to) existing plants, machinery and equipment than the economy as a whole.

PROFILES OF THE LEADING MINERALS PRODUCED IN CANADA

Gold

Canada has long been one of the world's leading producers of gold. For the fourth consecutive year, Canada trails only South Africa, the United States and Australia in the production of this precious metal. In 1998, Canada's gold output decreased from 171.5 t to 166.1 t, a decline of 3.1%. The value of gold production decreased by 8.1% to $2.3 billion. The average price of gold declined to US$294.11/troy oz in 1998, the lowest annual price since 1978. Price volatility was moderate with gold trading in a range of US$315-$273/oz. The main factors adversely affecting the price of gold are the world's central banks, which have been selling off or threatening to sell off significant quantities of their gold reserves. A strong U.S. dollar and a 3% decline in gold consumption for fabrication in 1998 were other factors contributing to the weakened price of gold. If current low prices continue (gold is averaging about US$282/oz early in 1999 and in mid-June 1999 was trading at under US$260/oz), gold production is likely to decline in Canada in 1999 and 2000 as mines close or suspend operations and companies merge or delay expansions.

About 40 primary gold mines operated in Canada at the end of 1998, accounting for over 90% of all the gold produced in Canada. Employment in these mines totaled an estimated 8964, down from 9656 in 1997 and continuing a general downward trend that started in 1989 when employment was 12 631.

Copper

The volume of copper produced in Canada rose 6.3% in 1998 to 688 600 t due to the start-up of several

mines, primarily in British Columbia. In spite of this increased volume, the value of the copper produced fell by more than 17% to $1.7 billion as copper prices declined from an average of US$1.03/lb in 1997 to an average of US$0.75/lb in 1998.

Copper's properties, especially its high electrical and thermal conductivity, good tensile strength, relatively high melting point and resistance to corrosion, make it and its alloys attractive for electrical transmission, water tubing, castings and heat exchangers. Despite reduced consumption in Southeast Asia, global copper consumption increased strongly in 1998 and should increase again in 1999, although at a slower rate. Copper prices, however, are expected to remain depressed in 1999, as world copper output continues to outpace demand, driving copper stockpiles to record levels. For the first half of 1999, copper prices have averaged less than US$0.65/lb, which is at or below the estimated average cost of production. Globally, this has resulted in the closing down of some production, the deferral of some new projects, and the extension of mine and smelter shut-downs. These are actions that analysts think are necessary to begin to rebalance the supply of copper and the amount consumed.

Zinc

Canada is the world's second largest producer of zinc, a metal used in the automotive and construction industries for the galvanization of steel and manufacture of die-cast alloys, in the production of brass, in semi-manufactures such as rolled zinc, and in chemical applications. In 1998, production of zinc (recoverable zinc in concentrates shipped) declined by 3.8% compared to 987 400 t in 1997. Zinc prices averaged US$0.464/lb in 1998, a 22.4% decrease over 1997 as a result of uncertainties related to the turmoil in Southeast Asian currency markets and the overall economic downturn in Asian, particularly Japanese, economies. These factors offset the generally positive fundamentals for zinc. World zinc consumption reached 7.8 Mt in 1998, a total that was slightly less than world refined zinc metal production. World consumption is expected to increase by about 3% in 1999 primarily due to increased demand in North America and Europe. Zinc stocks on the London Metal Exchange declined steadily throughout 1998 to finish at 317 000 t, or 175 000 t less than at the end of 1997.

For 1999, the zinc market is expected to remain fairly balanced. The continued market weakness in Japan and other Southeast Asian nations will probably continue to exert downward pressure on prices, which should average about US$0.45/lb. (Throughout the first half of 1999, the price has averaged slightly above US$0.45/lb.)

Nickel

Canada is the world's second largest nickel producer, trailing Russia and ahead of New Caledonia and Australia. Nickel's resistance to corrosion, high strength, pleasing appearance and suitability as an alloying agent are characteristics that make it useful in many applications. Major markets include stainless steel, nickel- and copper-based alloys, electroplating, alloy steels, and foundry products.

In 1998, nickel production in Canada increased by 11.2% over 1997 to 200 900 t. Quebec once again became a nickel producer in 1998 as Falconbridge Limited's Raglan mine began commercial production. As with other metals, the price of nickel declined sharply in 1998 compared to 1997. The effects of Asian financial problems translated into decreased demand by that region, especially by Japan. The stainless steel industry is the largest consumer of primary nickel, accounting for about two thirds of consumption. Consequently, the demand for nickel is largely a function of the demand for stainless steel and high-nickel alloy steels. After a 0.8% drop in world primary nickel consumption in 1998 to 1.0 Mt, consumption is expected to rise in 1999 to about 1.05 Mt. Nickel production in Canada will be dependent on the direction of prices. With nickel prices expected to remain low in 1999, Canadian nickel production should decline in that year. Production is expected to increase from the Raglan mine in 1999, the first full year of operation, but this should be more than offset by other nickel mine closures. For the first half of 1999, nickel prices have averaged a little above US$2.20/lb, compared to yearly averages of US$2.09/lb in 1998 and US$3.14/lb in 1997.

Iron Ore

Iron ore production levels in Canada remained virtually unchanged in 1998 at 38.9 Mt, while the value of production increased 0.8% to $1.58 billion. Over 80% of the volume and value of iron ore shipments are exported. The United States is the largest single customer, receiving 33% of the shipments in 1998. The European Union was the recipient of 53% of shipments of Canadian iron ore in 1998. Both of these percentages were similar to 1997 levels (35% to the United States and 53% to the European Union).

For 1999, prices were negotiated to lower levels on both the European (reduction of 11-14%) and Japanese (reduction of 11%) markets. Shipments for the first half of 1999 to all markets (the United States, Europe and Asia) are expected to be substantially lower than the levels reached in 1998 during the same period. The same situation may prevail for the second half of 1999 unless Asian economies recover.

The price for iron ore in 1999 dropped about US$2/t from the 1998/99 base of US$19/t, due mainly to weak

demand from the Asian steel industry. Australia and Brazil, which together supply over half the world iron ore market, set the price internationally in direct negotiations with Japanese and European steelmakers. To combat the lower prices in 1999, the three Quebec-Labrador iron ore companies, which mine virtually all of the iron ore produced in Canada, will seek new markets and further reduce their production costs. Also, some Canadian iron ore producers may be forced to temporarily lay off some of their employees for extended periods to adjust to the new market conditions.

Uranium

Canada is the world's largest producer and supplier of uranium, exporting about 80% of its production. The United States is the largest market for Canadian uranium. The world's two largest uranium-producing companies have operations in Canada. Uranium production in Canada declined by more than 10% in 1998 to 9980 t. ("Production" is defined as the metal content (U) reported by producers of uranium precipitates or concentrates.) Despite this decline, uranium still ranks solidly among Canada's top 10 metal commodities in terms of value of production. As for prices, the increase in spot market prices during the second half of 1997 was unsustainable, giving way to almost continuous decline throughout 1998. Reflecting the downward trend in spot prices, the average price of Canadian export deliveries also decreased from $51.30/kgU (US$14.20/lb U_3O_8) in 1997 to $51.10/kgU (US$13.30/lb U_3O_8) in 1998. Canadian producers were, to a large extent, sheltered from the price decline during 1998 by the weakness of the Canadian dollar relative to the U.S. currency.

The commercial fate of the uranium derived from dismantled Russian nuclear weapons remained unresolved in 1998 but, by year-end, there were encouraging signs that an agreement between the Russian Ministry of Atomic Energy and a consortium of Western companies might finally be concluded in 1999. An agreement would significantly reduce the uncertainty hanging over the international uranium market, providing a more stable environment for long-term investment decisions.

Silver

In Canada, silver is normally produced as a co-product of gold mining or base-metal mining. British Columbia is the leading silver-producing province, followed by New Brunswick, Ontario and Quebec. In 1998, Canada produced 1115 t of silver valued at $293.5 million, compared to 1194 t valued at $260.0 million in 1997. Silver was the only metal to buck the trend to lower prices in 1998 when prices averaged US$5.54/oz compared to US$4.90/oz in 1997. Even though the Silver Institute reported that demand for silver dropped 2.2% in 1998 to 840.6 million oz (the first decline in four years), consumption outstripped production for the tenth consecutive year. Ample inventories and sales of scrap metal are making up for the shortfall.

Potash

The term "potash" refers to a group of potassium-bearing minerals and chemicals. The dominant potash product is potassium chloride, a naturally occurring pink, salty mineral for which Canada is the world's leading producer and exporter. The main use of potash is in the agricultural sector where it is used to enhance the efficiency of plants in the uptake of nutrients. Other uses include detergents, ceramics, chemicals and pharmaceuticals. In 1998, potash was the third most valuable non-fuel mineral produced in Canada, trailing only gold and copper. In 1998, the value of potash produced in Canada totaled $1.67 billion, a 9.1% increase over 1997. At the end of 1998, the potash industry in Canada employed more than 3400 workers in eight underground mines and two solution mining operations in Saskatchewan and one underground mine in New Brunswick.

The world's potash supply/demand situation in 1998 was relatively balanced despite the prevalent financial crisis in Asia and the emergence of currency fluctuations in Latin America. Market conditions in 1998 were driven by a relatively stable demand, and suppliers reacted by adjusting production and sales, which led to an increase in inventories during the second half of 1998. Offshore potash price quotations were firm in 1998, registering a slight increase at the end of 1998 and in early 1999. For 1998, price quotations rose by 2% to average US$118.50/t standard KCl f.o.b. Vancouver.

Chrysotile

Chrysotile is regarded as the form of asbestos "least hazardous" to human health. It is the only form produced or extracted in Canada. Quebec is the only province currently producing chrysotile. In 1998, Canadian chrysotile shipments decreased by 23.9% from 1997 levels. Total shipments for 1998 were estimated to be 320 000 t valued at $167.2 million, compared to 420 278 t valued at $214.9 million in 1997. Canadian exports of chrysotile in 1998 were an estimated 319 430 t, a 25.7% decrease in volume from the previous year. The value of these exports decreased by 23.0% to $198.7 million. Because of depressed markets, due mainly to the continued Asian financial crisis and the European ban movement, employment in the Canadian chrysotile industry declined to about 1500 workers in 1998.

Salt

Canadians are the highest per capita consumers of salt in the world, due primarily to the extensive use

of salt as a de-icing agent to improve driving in wintry conditions. In 1998, Canadian salt (halite in geological terms) shipments were estimated at 13.2 Mt, a 2.3% decrease over 1997. The average unit value of salt shipments was estimated at $30.29/t, a 1% increase over that of 1997. In 1999, domestic production and consumption of salt are expected to remain stable.

Salt is a widespread, low value bulk commodity. It is relatively easy to extract and transportation represents a significant proportion of the total delivered price. As a consequence, international trade in salt is small relative to world production – about 20% of world production.

Gypsum

Canadian shipments of natural gypsum totaled 8.1 Mt valued at $88.0 million in 1998, compared to 8.6 Mt valued at $95.3 million in 1997. The decrease in shipments of natural gypsum (about 6%) resulted from weaker levels of construction activity in Canada and from a decrease in exports to the United States.

Most gypsum producers in Canada are closely integrated in both mining and wallboard manufacturing. Six companies operate 12 mines and 13 wallboard plants, in total employing about 1900 workers. Canadian housing starts are expected to be at least as high as 1998's 137 000 units and, with real economic growth in both Canada and the United States expected to continue, the outlook continues to be positive in the office and industrial building sectors, including renovation and repair work. Therefore, Canadian shipments of gypsum are expected to increase moderately in 1999.

Sulphur

In 1998, total sulphur production increased by 1.9% to 9.2 Mt. Elemental sulphur (recovered from natural gas and crude oil processing) accounted for 8.4 Mt, or 91% of the total. The additional 0.8 Mt was recovered from the smelting of metallic sulphides and the roasting of zinc-sulphide concentrates.

According to industry sources, at an estimated 5.2 Mt, Canadian sulphur offshore exports in 1998 were about 7% lower than in 1997, due mostly to much reduced exports to Morocco and Brazil, which are the largest offshore destinations for Canadian sulphur. Some of this reduction was offset by significantly higher exports to China. In addition, Canada exported 1.8 Mt of sulphuric acid, nearly all to the United States. Canadian imports were minimal and were mostly from the United States.

Entering 1998, sulphur price quotations on a free on board (f.o.b.) Vancouver basis were between US$38 and $30/t. Quotations decreased steadily, reaching a low of US$21-$23/t in June. Quotations remained at that level for the remainder of the year.

In 1999, the world sulphur market is expected to perform at a level equal to or slightly better than that of 1998. The consumption of phosphate fertilizers (the principal use of sulphur) is forecast to grow in most Asian regions. In 1999, Canadian production is expected to remain at, or slightly above, 1998 levels, and prices are expected to improve throughout the year.

Coal

Total Canadian coal production in 1998 was 74.4 Mt, 5.5% below the 1997 level. The value of coal production in 1998 totaled $1.8 billion, a 6.6% decrease compared to 1997. Metallurgical coal (used in the production of steel) accounted for about 37% of total coal production, the remaining 63% was thermal (used for the generation of electricity). Metallurgical coal production decreased by about 7% and thermal coal by 2%. Thermal coal exports were down some 10% at about 5.8 Mt, while metallurgical exports were down some 5% at about 29.0 Mt.

In 1999, metallurgical coal producers are facing an 18% price cut on coal exported to Japan from about US$50/t in 1998 to US$41.40/t. Weak demand from the Japanese steel industry and changing technology in the steel-making process are two factors causing this significant decline.

Coal is an organically derived material that is formed from the remains of decayed plant material compacted into a solid through millions of years of pressure and heat. It is the world's most abundant and widely distributed fossil fuel. In Canada, most of the coal is produced in the western provinces of Alberta (34.9 Mt in 1998), British Columbia (25.0 Mt) and Saskatchewan (12.0 Mt), with smaller amounts being produced in Nova Scotia and New Brunswick.

Structural Materials

The value of all structural materials produced in Canada (clay products, cement, lime, sand and gravel, and stone) was $2.9 billion in 1998, a 2.2% increase over 1997. The highest valued product of the structural materials group is cement. In 1998, the value of cement produced was $1.1 billion, 6% above the 1997 figure. Demand for cement in Ontario remained relatively strong, although in British Columbia there was a substantial decrease in demand. Overall construction activity was weaker than in 1997, affected by an 8% drop in residential construction. Cross-border trade of cement with the United States varies considerably from year to year depending on demand. Canadian cement production efficiencies and a lower-valued Canadian dollar (relative to the U.S. currency) continue to make Canadian cement competitive in

U.S. markets. Annual exports of cement to the United States amount to 3-4 Mt and account for about one third of total Canadian shipments.

Cement shipments in 1999 are expected to increase mainly based on relatively low interest rates, continued recent strength in both residential and non-residential building construction, and a stable demand for exports.

The value of sand and gravel produced in Canada in 1998 declined by 1.1% to $819.9 million, the value of stone increased slightly to $646.2 million, and the value of lime increased to $220.5 million. The value of clay products declined by 0.7% to $135.3 million.

Diamonds

On October 14, 1998, BHP Diamonds Inc. opened the Ekati mine in the Northwest Territories, Canada's first major diamond mine. By the end of the year, the mine had produced nearly 200 000 carats (ct). Once full capacity is reached, annual production is expected to be about 3.5-4.5 Mct. At that level, the Ekati mine will account for about 4% of global diamond production by weight and 6% by value.

In 1998, exploration for diamonds continued in several regions of Canada. Preliminary data indicate that diamond exploration expenditures declined from $92.2 million in 1997 to $73.9 million in 1998. Exploration was focused principally in the Northwest Territories.

In comparison to other countries with cutting and polishing industries, the Canadian industry is quite small. However, the start of Canada's mine production of rough diamonds has created interest in establishing new facilities in this country.

Worldwide, the demand for polished diamonds of a size between 0.75 ct and 2-3 ct with good colour and clarity is expected to continue to be strong. The surplus of small inexpensive polished diamonds should continue for a few years. Prices for natural industrial diamonds should continue to decline if world production remains at its present level, or increases, due to strong competition from synthetic diamonds.

Looking Ahead for the Mineral Industry

The outlook for the Canadian mineral industry in 1999 was not promising as the year 1998 came to a close. Mineral commodity prices, which fell to depressed levels during 1998, are expected to remain near their lows and not to rebound significantly until weak global demand and surplus supply conditions for many minerals and metals are brought more in balance. Unfortunately, there is added negative pressure on the supply side with large low-cost mines, particularly for nickel, copper and gold, coming on stream around the world. Furthermore, global steelmaking, which is a major consumer of mineral-based commodities, looks particularly weak. In early 1999, benchmark international contracts for metallurgical coals, which are directly related to steelmaking, were being renegotiated with prices for 1999 being, on average, about 18% lower than the 1998 international price of about US$50/t f.o.b. port. In some cases, shipments were also being reduced. Similarly, iron ore contract benchmark prices were down about 11% for 1999.

Even though natural resource sectors such as forestry, agriculture and minerals remain depressed, the Canadian economy is expected to expand in 1999, but at a slower pace. GDP growth is estimated to be in the 2.5% range, down from 3.0% in 1998 and 3.8% in 1997. Even with a 2.5% growth rate, Canada would still be near the top of the G7 countries for 1999. A capital spending survey by Statistics Canada indicates that capital spending is expected to be flat in 1999 after five years of growth, although energy projects in Quebec, New Brunswick and Newfoundland will increase activity in these provinces. Inflation is expected to continue at an annual rate of about 1-1.5%, while the Bank of Canada interest rate is expected to remain around the 5.25% that prevailed at the end of 1998. Unemployment, which was at 8.0% at the end of 1998, dropped to 7.8% in early 1999. However, with a slowing economy and a likely fall-off in the strong consumer spending, which was a driving force in both 1997 and 1998, the rate can be expected to be under pressure to rise above this level as the year progresses.

On a global basis, most forecasters are looking at GDP growth of about 1.5% for the world's economy in 1999 and about 2.5% in 2000. The Latin American and Japanese economies are expected to decline in 1999, but by 2000 are expected to improve. Economies in North America and Western Europe are expected to remain steady, with the U.S. economy still leading the way with a continuing strong performance, but these economies could be adversely affected by countries trying to export their way out of economic difficulties.

For Canadian mineral producers, an excess of production and the economic weakness in global markets will maintain ongoing downward pressure on most mineral commodity prices and, consequently, on the financial health and outlook of these companies. There will therefore be continued efforts by producers to cut operating costs. Mining operations currently at the higher end of the cost curve will be under added pressure to close, to consider merger opportunities, or to be the target of takeover bids. All of these actions reinforce the long-term global trend of declining mineral commodity prices. New mine investment, exploration activity and mining employment can be expected to be down again in Canada in 1999 due to continuing weakness in the mining sector.

As shown in this article, while still going through difficult times, the mining industry continues to make a major contribution to the Canadian economy. Mining has been viewed as a relatively low-tech industry when compared with manufacturing, where automated on-line production processes have helped firms compete and restore profit margins. However, the mining industry is now heading in the same direction as it automates more of its operations. For example, companies such as Inco Limited are now in the early stages of controlling different aspects of underground activity with operators working on the surface, a new method referred to as "telemining." Canada's mining industry is a world leader in these kinds of innovations, which also include geo-sensing, laser-guidance systems and 3-D animation and simulation applications.

The mining industry has been under severe profit margin pressures. Applying technical advances in automation, robotics and telecommunications will result in better safety, more accurate drilling and blasting, faster ore extraction, higher output, productivity gains, and lower costs. Earlier automation moves have already achieved significant productivity gains, improved drill-bit lifetimes and lowered maintenance costs. These changes will likely result in fewer underground mine employees, but will also create well-paid, skilled surface jobs and will make mining safer. If increased automation allows Canada's mining companies to compete more successfully, it will create wealth for mining communities and benefit the whole economy. Technological innovation in the mining industry is a very positive development for the industry's future.

Note: Information in this review was current as of June 18, 1999.

TABLE 1. CANADA, PRODUCTION OF LEADING MINERALS, 1997 AND 1998p

		Volume		Percent Change	Value		Percent Change
		1997	1998p	1998/1997	1997	1998p	1998/1997
		(000 tonnes except where noted)			($ millions)		
METALS							
Gold	kg	171 479	166 089	–3.1	2 527.4	2 322.4	–8.1
Copper		648	689	6.3	2 050.9	1 693.2	–17.4
Iron ore		38 928	38 908	–0.1	1 571.7	1 584.1	0.8
Zinc		1 027	987	–3.8	1 870.9	1 487.0	–20.5
Nickel		181	201	11.2	1 775.9	1 419.4	–20.1
Uranium	tU	11 127	9 984	–10.3	553.9	x	x
Silver	t	1 194	1 115	–6.6	260.0	293.5	12.9
Platinum group	kg	11 836	14 522	22.7	134.2	222.9	66.0
Cobalt	t	2 168	2 324	7.2	154.4	167.7	8.6
Lead		171	152	–11.2	147.6	118.0	–20.0
Molybdenum	t	7 594	7 563	–0.4	87.6	82.4	–5.9
NONMETALS							
Potash (K_2O)		9 235	8 969	–2.9	1 528.3	1 667.0	9.1
Salt		13 497	13 192	–2.3	405.5	399.5	–1.5
Peat		1 054	1 127	6.9	146.4	169.7	15.9
Asbestos		420	320	–23.8	214.9	167.2	–22.2
Gypsum		9 628	8 095	–6.2	95.3	88.0	–7.7
Sulphur in smelter gas		800	838	4.8	59.5	58.3	–1.9
Sulphur, elemental		8 272	8 410	1.7	84.1	54.3	–35.4
Diamonds	000 carats	–	278	n.a.	–	53.4	n.a.
Nepheline syenite		648	617	–4.8	51.3	50.2	–2.2
STRUCTURAL MATERIALS							
Cement		11 736	12 064	2.8	1 062.7	1 126.9	6.0
Sand and gravel		225 495	217 650	–3.5	829.2	819.9	–1.1
Stone		99 265	95 998	–3.3	644.2	646.2	0.3
Lime		2 477	2 514	1.5	213.0	220.5	3.5
Clay products		. .	. .	. .	136.3	135.3	–0.7
MINERAL FUELS							
Crude oil and equivalent	000 m^3	123 827	128 769	4.0	17 837.8	12 990.3	–27.2
Natural gas	million m^3	156 171	161 015	3.1	10 719.2	11 196.0	4.4
Coal		78 670	74 370	–5.5	1 920.2	1 793.2	–6.6
Natural gas by-products	000 m^3	26 527	26 612	0.7	2 599.2	1 790.6	–31.1

Sources: Natural Resources Canada; Statistics Canada, *Canada's Mineral Production, Preliminary Estimates*, cat. no. 26-202-XIB.
– Nil; . . Not available; n.a. Not applicable; p Preliminary; x Confidential.
Note: Numbers have been rounded.

TABLE 2. CANADA, STAGE I TO STAGE IV, DOMESTIC EXPORTS OF MINERALS AND MINERAL PRODUCTS BY COMMODITY, 1996-98

	Unit of Measure	1996		1997		1998p	
	(000)	(Quantity)	($000)	(Quantity)	($000)	(Quantity)	($000)
METALS							
Aluminum	. .	. .	6 328 775	. .	7 127 264	. .	7 137 180
Antimony	kg	1 434	2 332	244	875	769	1 403
Bismuth	kg	141	1 517	135	1 415	175	2 015
Cadmium	kg	1 722	8 198	2 622	5 612	2 097	3 205
Calcium metal	kg	4 570	3 655	5 685	4 281	5 616	3 661
Chromium	kg	8 749	29 370	7 902	33 642	7 085	31 948
Cobalt	kg	5 120	385 335	6 356	431 471	6 911	463 890
Copper	. .	. .	3 028 916	. .	2 929 108	. .	2 385 148
Gold	. .	. .	3 547 590	. .	3 485 710	. .	3 384 271
Iron and steel	. .	. .	8 238 652	. .	8 495 816	. .	9 606 446
Iron ore	t	27 920	1 032 860	32 340	1 262 406	30 180	1 286 304
Lead	. .	. .	430 810	. .	334 083	. .	284 009
Magnesium and magnesium compounds	kg	101 974	221 788	106 592	252 921	111 542	273 808
Molybdenum	kg	8 771	71 562	11 303	91 702	10 759	67 691
Nickel	. .	. .	2 339 044	. .	2 119 890	. .	1 903 017
Platinum group	. .	. .	158 116	. .	182 857	. .	207 789
Silver	. .	. .	433 218	. .	350 772	. .	507 443
Tin	. .	. .	20 261	. .	17 343	. .	13 793
Uranium and thorium	. .	. .	960 516	. .	970 889	. .	785 718
Zinc	kg	1 331 509	1 486 297	1 121 286	1 789 170	1 054 247	1 526 058
Other metals	. .	. .	3 510 826	. .	4 112 100	. .	4 780 624
Total metals		. .	32 239 638	. .	33 999 327	. .	34 655 421
NONMETALS							
Asbestos	. .	. .	353 188	. .	308 350	. .	264 060
Barite and witherite	t	15	5 285	21	5 907	25	9 158
Diamonds	kg	. .	16 794	. .	13 660	110	6 869
Graphite	. .	. .	132 208	. .	132 581	. .	126 945
Gypsum	. .	. .	230 768	. .	288 927	. .	341 734
Mica	t	17	9 516	16	9 240	18	11 308
Nepheline syenite	t	269	43 919	372	50 498	338	52 205
Peat	. .	. .	289 132	. .	288 094	. .	320 061
Potash and potassium compounds	kg	12 961 046	1 546 155	14 647 353	1 752 693	14 278 275	1 978 593
Salt and sodium compounds	t	4 959	543 287	4 727	503 537	5 227	542 661
Sulphur and sulphur compounds	kg	7 697	495 545	8 185	468 190	6 803	356 041
Talc, soapstone and pyrophyllite	kg	26	7 607	26	8 010	30	10 227
Titanium oxides	kg	69 781	152 332	79 185	172 758	83 861	211 129
Other nonmetals	. .	. .	2 549 744	. .	2 842 054	. .	2 798 073
Total nonmetals		. .	6 375 480	. .	6 844 499	. .	7 029 064
STRUCTURAL MATERIALS							
Cement	. .	. .	506 880	. .	573 844	. .	628 957
Clay and clay products	. .	. .	41 809	. .	44 475	. .	39 427
Lime	kg	216 849	24 701	224 233	27 203	171 447	21 304
Sand and gravel	t	1 428	11 844	1 809	15 680	1 999	19 737
Silica and silica compounds	. .	. .	13 995	. .	18 370	. .	16 426
Stone	. .	. .	104 479	. .	128 992	. .	153 370
Other structural materials	. .	. .	49 807	. .	57 682	. .	96 407
Total structural materials		. .	753 515	. .	866 246	. .	975 628
FUELS							
Coal and coke	t	34 979	2 620 374	36 158	2 734 570	33 258	2 504 909
Natural gas	000 m^3	80 117	7 432 768	81 795	8 625 631	87 326	8 858 923
Natural gas by-products	000 m^3	8	1 154 199	8	1 161 236	9	860 303
Petroleum	. .	. .	17 040 149	. .	17 003 934	. .	12 978 294
Other fuels	kg	193 888	251 406	163 634	257 592	163 696	269 320
Total fuels		. .	28 498 896	. .	29 782 963	. .	25 471 749
Total mineral domestic exports (including fuels)		. .	67 867 529	. .	71 493 035	. .	68 131 862
Total economy domestic exports		. .	259 265 000	. .	281 255 740	. .	296 699 975

Sources: Natural Resources Canada; Statistics Canada.
. . Not available or not applicable; p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 3. CANADA, STAGE I TO STAGE IV, IMPORTS OF MINERALS AND MINERAL PRODUCTS BY COMMODITY, 1996-98

	Unit of Measure	1996		1997		1998p	
	(000)	(Quantity)	($000)	(Quantity)	($000)	(Quantity)	($000)
METALS							
Aluminum	. .	. .	3 373 306	. .	3 827 343	. .	4 359 671
Antimony	kg	2 515	11 917	2 514	11 017	2 670	9 747
Bismuth	kg	98	2 102	237	3 043	220	2 426
Cadmium	kg	736	1 502	487	1 341	35	607
Calcium metal	kg	44 889	35 803	53 902	40 576	74 768	47 542
Chromium	kg	112 877	94 366	104 999	97 948	96 008	93 994
Cobalt	kg	1 123	70 232	1 213	63 955	1 522	62 975
Copper	. .	. .	1 648 903	. .	1 810 201	. .	1 624 140
Gold	. .	. .	1 077 642	. .	1 438 458	. .	1 577 937
Iron and steel	. .	. .	10 245 590	. .	12 912 369	. .	15 379 922
Iron ore	t	6 911	334 255	7 148	357 847	7 255	387 944
Lead	. .	. .	498 422	. .	551 199	. .	589 792
Magnesium and magnesium compounds	kg	390 826	157 023	326 106	203 457	277 286	186 701
Molybdenum	kg	3 686	38 652	3 677	40 489	4 216	41 009
Nickel	. .	. .	757 023	. .	599 185	. .	639 258
Platinum group	g	243 738	207 343	266 556	228 667	195 251	182 448
Silver	. .	. .	125 790	. .	142 383	. .	136 801
Tin	. .	. .	56 634	. .	59 240	. .	61 700
Uranium and thorium	. .	. .	248 005	. .	219 999	. .	223 827
Zinc	. .	. .	153 816	. .	275 855	. .	234 856
Other metals	. .	. .	6 887 494	. .	8 348 454	. .	10 003 004
Total metals			26 025 820		31 233 026		35 846 301
NONMETALS							
Asbestos	. .	. .	75 281	. .	85 281	. .	81 023
Barite and witherite	t	16	1 868	22	2 994	14	2 479
Diamonds	. .	. .	191 132	. .	223 942	. .	251 119
Graphite	. .	. .	335 829	. .	369 379	. .	447 787
Gypsum	. .	. .	24 787	. .	30 779	. .	36 164
Mica	t	4	10 460	4	12 369	5	11 469
Nepheline syenite	. .	. . .	52	. . .	12	. . .	3
Peat	. .	. .	750	. .	1 289	. .	2 743
Potash and potassium compounds	kg	. .	35 430	. .	39 055	118 389	41 588
Salt and sodium compounds	t	2 155	325 159	2 306	318 140	1 930	308 783
Sulphur and sulphur compounds	kg	110	15 975	152	19 096	189	21 688
Talc, soapstone and pyrophyllite	kg	58	15 283	56	13 072	47	12 173
Titanium oxides	kg	84 713	180 046	111 291	231 247	117 814	272 653
Other nonmetals	. .	. .	3 122 830	. .	3 480 783	. .	3 959 731
Total nonmetals			4 334 882		4 827 438		5 449 403
STRUCTURAL MATERIALS							
Cement	. .	. .	157 885	. .	188 201	. .	210 343
Clay and clay products	. .	. .	671 334	. .	762 951	. .	862 270
Lime	kg	36 640	5 054	47 382	6 380	33 988	5 752
Sand and gravel	t	3 241	16 300	3 207	17 619	3 068	18 955
Silica and silica compounds	. .	. .	109 098	. .	125 737	. .	143 146
Stone	. .	. .	93 950	. .	105 411	. .	134 142
Other structural materials	. .	4	57 623	4	67 242	. .	78 031
Total structural materials			1 111 244		1 273 541		1 452 639
FUELS							
Coal and coke	t	12 860	757 557	15 939	879 158	20 880	1 141 455
Natural gas	000 m^3	1 923	111 361	953	137 292	734	103 999
Natural gas by-products	000 m^3	. . .	70 227	. . .	56 091	. . .	56 626
Petroleum	. .	. .	9 592 959	. .	11 428 616	. .	9 143 758
Other fuels	. .	. .	306 498	. .	347 478	. .	449 774
Total fuels			10 838 602		12 848 635		10 895 612
Total mineral imports (including fuels)			42 310 548		50 182 640		53 643 955
Total economy imports			232 648 033		272 855 758		298 316 804

Sources: Natural Resources Canada; Statistics Canada.
. . Not available or not applicable; . . . Amount too small to be expressed; p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 4. CANADA, VALUE OF DOMESTIC EXPORTS, TOTAL EXPORTS (INCLUDING RE-EXPORTS), IMPORTS, AND BALANCE OF TRADE OF MINERALS AND MINERAL PRODUCTS, STAGES I TO IV, 1994-98

	1994	1995	1996	1997	1998
			($000)		
TOTAL MINING, INCLUDING FUELS					
Domestic exports	53 514 519	61 638 947	67 867 537	71 493 041	68 131 860
Total exports	54 315 676	63 094 715	69 082 164	72 962 766	69 264 551
Imports	35 621 152	39 877 705	42 310 542	50 182 644	53 643 958
Balance of trade	18 694 524	23 217 010	26 771 622	22 780 122	15 620 593
NON-FUEL MINING					
Domestic exports	32 673 188	38 262 167	39 368 642	41 710 077	42 660 112
Total exports	33 164 779	38 927 197	40 078 786	42 539 760	43 643 003
Imports	27 700 890	30 874 074	31 471 941	37 334 009	42 748 347
Balance of trade	5 463 889	8 053 123	8 606 845	5 205 751	894 656
TOTAL NON-FUEL MINING, INCLUDING COAL					
Domestic exports	34 834 414	40 629 187	41 989 016	44 444 647	45 165 020
Total exports	35 326 376	41 298 243	42 700 792	45 275 387	46 148 907
Imports	28 277 764	31 564 042	32 229 497	38 213 167	43 889 802
Balance of trade	7 048 612	9 734 201	10 471 295	7 062 220	2 259 105
TOTAL ECONOMY					
Domestic exports	213 290 163	248 440 788	259 265 000	281 255 740	296 699 975
Total exports	226 475 000	264 207 000	275 773 600	299 089 922	317 902 296
Imports	202 737 000	225 629 195	232 648 033	272 855 758	298 316 804
Balance of trade	23 738 000	38 577 805	43 125 567	26 234 164	19 585 492

Sources: Natural Resources Canada; Statistics Canada.

Canadian Reserves of Selected Major Metals, and Recent Production Decisions

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RESERVES OF SELECTED MAJOR METALS

Canadian reserves of copper, nickel, lead, zinc, silver and gold decreased significantly during 1997. Only molybdenum reserves were higher than in 1996 (Table 1).

Generally declining metal prices during 1997 caused many mining companies to make their ore reserve calculations at year-end based upon lower metal prices than they had used at the end of 1996. This resulted in reductions of ore reserves at most producing mines and a number of mine closures.

In Canada during 1998, there were only two announcements of new production decisions for the seven metals reviewed in this chapter. Given that metal prices continued to fall during 1998, it is probable that Canadian ore reserve levels for the major metals will continue to decline in the immediate future. The Voisey's Bay nickel-copper-cobalt deposit in Labrador is not presently included in Canadian reserves because there are several major issues to be resolved before production can begin. When a production decision is made, it will result in major increases in the reserves of nickel and copper.

Reserves Policy

Canadian reserves are estimated from information contained in annual and other corporate reports, and from the responses of mining companies to the annual Federal-Provincial Survey of Mines and Concentrators.

Reserves reported here include only metal contained in material that is classified by companies as "proven" or "probable" (or their equivalents) at producing mines and in deposits that are firmly committed to production (Table 2). Metal contained in mineral resources classified by companies as "possible" (or its equivalents) is not included in national totals, nor is metal contained in deposits that have not advanced beyond the deposit appraisal phase (Figure 1). When available, only metal contained in mineable ore is included in Canadian totals so as to exclude losses inherent in the mining process. Every effort is made to achieve, from year to year, consistency in the reserves reported here; however, consistency ultimately depends on industry practice, which has evolved over the years. Imperial units reported by companies have been converted to metric units and the results have been rounded to the appropriate number of significant digits.

Reserves by Commodity

Gold

There were 1510 t of gold contained in Canadian mine reserves in December 1997. This represents a decrease of 12% compared to revised totals for December 1996. The major components of this decrease were the downward revisions of reserves at the Ontario Division (-80 t) of Royal Oak Mines Inc. and the Dome mine (-28 t) of Placer Dome Inc. in Ontario. Most gold producers were unable to replace the ore mined during 1997, but the Doyon mine in Quebec and the Musselwhite mine in Ontario were notable exceptions with increases of 14 t and 21 t, respectively.

Silver

There were 16 697 t of silver contained in Canadian mine reserves in December 1997. This represents a decrease of 12% compared to revised totals for December 1996. The major components of this decrease were the downward revision of reserves at the Brunswick No. 12 mine (-943 t) in New Brunswick, and the closure of the Faro mine (-904 t) in the Yukon. The only silver-producing mines to significantly increase their reserves during 1997 were the LaRonde mine (+291 t) in Quebec and the Eskay Creek mine (+190 t) in British Columbia.

Zinc

During 1997, Canadian reserves of zinc decreased to about 10.6 Mt, down by about 22% compared to the

Figure 1
Generalized Model of the Process of Mineral Resource Development and Mining

PHASES	MINERAL RESOURCE ASSESSMENT	MINERAL EXPLORATION					MINERAL DEPOSIT APPRAISAL				DEVELOPMENT OF MINE COMPLEX	MINERAL PRODUCTION	ENVIRON-MENTAL RESTORATION
	MRA	EX-1	EX-2	EX-3	EX-4	EX-5	DA-1	DA-2	DA-3	DA-4	MC	MP	ER
STAGES	Surveys, research, synthesis.	Exploration planning.	Regional reconnaissance and surveys.	Prospecting and ground survey of anomalies.	Verification of anomalies and showings.	Discovery and delimitation.	Deposit definition.	Project engineering.	Project economics.	Feasibility study. Production decision.	Construction of plant and infra-structure. Mine preparation.	Production, marketing, new development.	Mine closure. Site reclamation and restoration.
OBJECTIVES	Supply informa-tion and tools required to develop the mineral potential of the nation for economic benefit in the perspec-tive of sustained development.	Select target commodities. Establish exploration objectives and strategies. Select target areas.	Find regional and more local-ized anomalies. Select significant targets.	Acquire proper-ties. Confirm presence, exact location and characteristics of anomalies.	Acquire addi-tional properties as required. Verify and con-firm anomalies. Find mineral showings.	Discover, con-firm and delimit a mineral deposit of economic interest. Evalu-ate technical and economic poten-tial in a prelimi-nary fashion.	Define the grade, limits, internal distribution, controls and the mineralogy-processing parameters of a mineral deposit. Acquire data to support engi-neering planning.	Establish tech-nical feasibility. Prepare realistic plans, schedules, investment-cost and operating-cost estimates for all aspects of a project.	Establish para-meters for economic and financial evaluation.	Ensure validity of project data, assumptions and evaluation results. Decide whether or not to undertake a mining project at this time. Obtain the required permits. Obtain financing.	Complete mine development and construction on schedule and within budget. Ensure efficient and timely mine and concentrator start-up.	Achieve planned rate and speci-fications of commercial production on schedule and within budget. Achieve mine profitability, company survival and sustained development.	Restore mine site to an environmentally acceptable condition.
EVALUATION METHODS	Geoscientific, mineral and economic sur-veys, research, compilations and synthesis by governments, research institutes and universities.	Metal and mineral market research. Review of geological and ore deposit information for various areas. Review legal and political context. Use of deduction and intuition.	Satellite imagery, aerial photo-graphy and airborne geophysics. Prospecting, geology and geochemistry. Appraisal, rating and selection of anomalies.	Ground-based geological, geo-chemical and geophysical prospecting and surveys. Review and selection of significant anomalies.	Geological mapping and other surveys. Trenching and sampling. Review of results and selection of targets.	Stripping, trench-ing, detailed mapping, sampl-ing, drilling and down-hole geo-physics. Prelimi-nary deposit inventory and evaluation. Environmental characterization and site surveys.	Detailed map-ping, sampling and drilling on surface or from underground. Systematic mineral processing tests. Detailed environ-mental and site surveys.	Pilot tests and engineering studies. Design and cost estimation for mining, ore concentration, metal extraction, infrastructure, protection of the environment and restoration.	Market, price, cost and other financial studies. Technical, environmental, economic, financial, social and political risk analysis.	Exhaustive due diligence review of geological, engineering, environmental, economic, legal and site data. Evaluation of profitability, risks and up-side factors of a project.	Project and quality manage-ment methods. Training program for personnel and detailed start-up plan.	Production management using continuous quality improve-ment methods. Exploration, appraisal and development of new ore zones, both on-property and off-property.	Mine closure and decommission-ing. Environ-mental restora-tion and monitoring.
RESULTS	Geoscientific, mineral and economic data bases, maps and models.	Exploration projects.	Regional anomalies.	Local anomalies.	Mineral showings.	Mineral deposit.	Deposit appraisal project.			Mining project.	Mining plant.	Mineral production.	Restored site.
FEASIBILITY STUDIES						Expected margin of error of estimates at the 90% confidence level:							
						± 100%	± 50%	± 40%	± 20%	± 10%		± 5%	Full compliance
INVESTMENT AND RISK	Moderate	Low but increasing investment. Very high, but decreasing risk of failure and financial loss.					Much larger and increasing investment. High, but decreasing risk of failure.				Large industrial investment. Low to moderate industrial risk.		
MINERAL INVENTORY	Undelimited mineral resources						Delimited mineral resources				Ore reserves		Delimited mineral resources
	Speculative	Hypothetical				Inferred	Indicated and measured				Proven and probable		

Sources: Modified by D.A. Cranstone, A. Lemieux and M. Vallée, February 25, 1994, from M. Vallée, 1992, *Guide to the Evaluation of Gold Deposits*, CIM Special Volume 45, p. 4, and *SOQUEM Annual Report*, 1976-77, pp. 4-5. Revised by M. Vallée March 8, 1996.

previous year. The major components of this decrease were the closures of the Faro mine (-889 t) in the Yukon and the Isle Dieu Mattagami mine (-499 t) in Quebec, as well as the downward revision of reserves at the Brunswick No. 12 mine (-864 t) in New Brunswick. The only zinc mines to significantly increase their ore reserves in 1997 were Gallen (+28 t) and LaRonde (+226 t) in Quebec.

Lead

Canadian reserves of lead decreased by approximately 32% during 1997, largely as a result of the closure of the Faro mine (-542 t) in the Yukon and the downward reassessment of reserves at the Brunswick No. 12 mine (-358 t) in New Brunswick.

Copper

In December 1997, Canadian reserves of copper were estimated at about 9 Mt, or down by about 7% from a year earlier. Copper reserves were reduced as a result of the closures of the Isle Dieu Mattagami (-51 t), Copper Rand (-12 t) and Portage (-3 t) mines in Quebec, and the Afton mine (-6 t) in British Columbia. However, the downward revision of reserves at Inco Limited's operations, and the closure of the Shebandowan mine in Ontario, had a much greater effect in reducing copper reserves during 1997.

Molybdenum

Canadian reserves of molybdenum stood at 149 000 t in December 1997, or about 3% higher than in the previous year. This increase was largely due to successful exploration at the Endako mine in British Columbia.

Nickel

In December 1997, there were some 5.1 Mt of nickel contained in Canadian mine reserves, down by approximately 9% from 1996 levels. This decrease is due largely to the downward revision of Inco's reserves. Falconbridge Limited's reserves increased as a result of successful exploration in the vicinity of the Raglan mine in Quebec.

Inco had some 4.2 Mt of nickel in Canadian reserves at the end of 1997, or about 82% of the national total. It is expected that development of the copper-nickel-cobalt deposits at Voisey's Bay in Labrador will make major additions to Canada's mineable reserves of these metals in the near future.

Canadian Reserves by Province and Territory

Three provinces (Ontario, British Columbia and New Brunswick) held dominant positions in terms of Canada's proven and probable mineable reserves of major metals in December 1997 (Table 4).

Ontario had 66% of the nickel, 50% of the gold and 43% of the copper, plus 18% of the silver and 14% of the zinc.

British Columbia had 100% of the molybdenum, 41% of the copper and 32% of the silver, plus 13% of the lead, 10% of the zinc and 19% of the gold.

New Brunswick had 79% of the lead, 43% of the zinc and 32% of the silver, plus 2% of the copper and 2% of the gold.

Quebec had 20% of the zinc, 18% of the gold, 10% of the copper, 10% of the nickel and 14% of the silver.

Manitoba had 23% of the nickel, 5% of the zinc and 4% of the gold, plus 4% of the copper and 2% of the silver.

The Yukon Territory had less than 2% of the gold and the silver.

The Northwest Territories had 7% of the zinc, 6% of the lead and 4% of the gold.

Canadian Reserves by Industry

Canadian mines are, to a large extent, polymetallic, a complexity that the Standard Industrial Classification (SIC) tends to oversimplify (Table 5).

Current mine reserves of gold in Canada are distributed through the various SIC classes as follows: gold mines, 77%; copper and copper-zinc mines, 16%; nickel-copper mines, 4%; and zinc-lead-silver mines, 3%. Current mine reserves of silver in Canada are distributed through the various SIC classes as follows: gold mines, 27%; copper and copper-zinc mines, 30%; nickel-copper mines, 8%; and zinc-lead-silver mines, 35%.

Current mine reserves of copper in Canada are distributed through the various SIC classes as follows: gold mines, 1%; copper and copper-zinc mines, 59%; nickel-copper mines, 38%; and zinc-lead-silver mines, 2%. Current mine reserves of molybdenum in Canada are contained in the SIC classes as follows: copper and copper-zinc mines, 41%; and molybdenum mines, 59%.

Current mine reserves of nickel in Canada are contained entirely in the SIC class of nickel-copper mines.

Current mine reserves of lead in Canada are contained in the SIC classes as follows: copper and copper-zinc mines, 3%; and zinc-lead-silver mines, 97%. Current mine reserves of zinc in Canada are contained in the SIC classes as follows: gold mines, 3%; copper and copper-zinc mines, 39%; and zinc-lead-silver mines, 58%.

Apparent Life of Canadian Reserves

The apparent life (life index) of mine reserves is usually calculated by dividing the total amount of metals remaining in mine reserves at the end of a given year by the corresponding amount of metals contained in the ores produced during that year. Similar calculations are often applied at the national level.

At the national level, life indices are but a very rough measure of the expected life of aggregate mine reserves, and they are often misleading unless abnormal situations are recognized. Life indices based on proven and probable reserves do not make allowances for inferred extensions to reserves at current mines, gross additions that will accrue to current reserves from the likely development, in the foreseeable future, of known orebodies for which a production decision has yet to be made, or expected changes in production rates. Furthermore, life indices tend to overstate the apparent life of reserves when, for example, annual production is abnormally low due to strikes, cutbacks or suspensions at large establishments, or when significant increases in capacity resulting from new production decisions will be coming on stream, but only several years hence.

The apparent life indices for the major metals in Canada at the end of 1997 were 22 years for nickel, 13 years for copper, 11 years for molybdenum, 11 years for silver, 10 years for lead, 9 years for zinc, and 8 years for gold.

Reserve Trends

Figure 2 and Table 6 show how Canadian reserves of copper, lead, molybdenum, nickel, silver and zinc have declined steadily since the early 1980s. In contrast, gold reserves increased substantially until 1988, before starting a gradual decline. In 1994, these trends began to be arrested or reversed. This reversal started with increases in Canadian reserves of zinc, gold and silver in 1994, followed by increases in Canadian reserves of zinc, gold and nickel in 1995, and increases in Canadian reserves of gold, nickel and molybdenum in 1996. Canadian reserves of gold in 1996 were higher than in any year since the peak year of 1988. The sharp decline in reserves during 1997 cancelled most of the gains of 1994 through 1996 so that, at the end of 1997, Canadian reserves of copper, nickel, lead and zinc were lower than at any time since Natural Resources Canada began keeping records, and reserves of molybdenum and silver were close to the historic lows that were realized in 1995 and 1993 respectively. Only Canadian reserves of gold remained near the historically high values of 1988 and 1996.

The annual aggregate change in Canadian reserves is the net result of three main factors affecting individual mines (Figure 3): additions to reserves, deletions to reserves, and production. Additions to reserves are the result of new discoveries; of new geological, metallurgical, production or other information; of a decrease in production costs; or of a rise in commodity prices, all of which increase the quantity of mineral resources that are profitable to mine. Deletions to reserves are the result of new geological, metallurgical, production or other information; of increases in costs; or of decreases in commodity prices, all of which reduce the quantity of mineral resources previously counted in mine reserves that are now expected to be mined at a profit. Production is normally the main factor reducing the reserves at individual mines but, in 1997, declining metal prices were a significant factor in the reduction of ore reserves at producing mines.

Recent Production Decisions

Several criteria need to be met for a project to be considered here to have reached the production decision stage. In general, there needs to have been a positive production feasibility study, all of the necessary permits must have been obtained, financing must have been arranged, and directors must have approved construction.

During 1998, production decisions were announced for the Konuto Lake mine at Creighton, Saskatchewan, and for the Black Dome mine near Clinton, British Columbia.

Inco Limited's Voisey's Bay deposit in Labrador is poised for a production decision, but it is not included as a 1998 production decision because not all of the necessary permits and agreements were in place at that time.

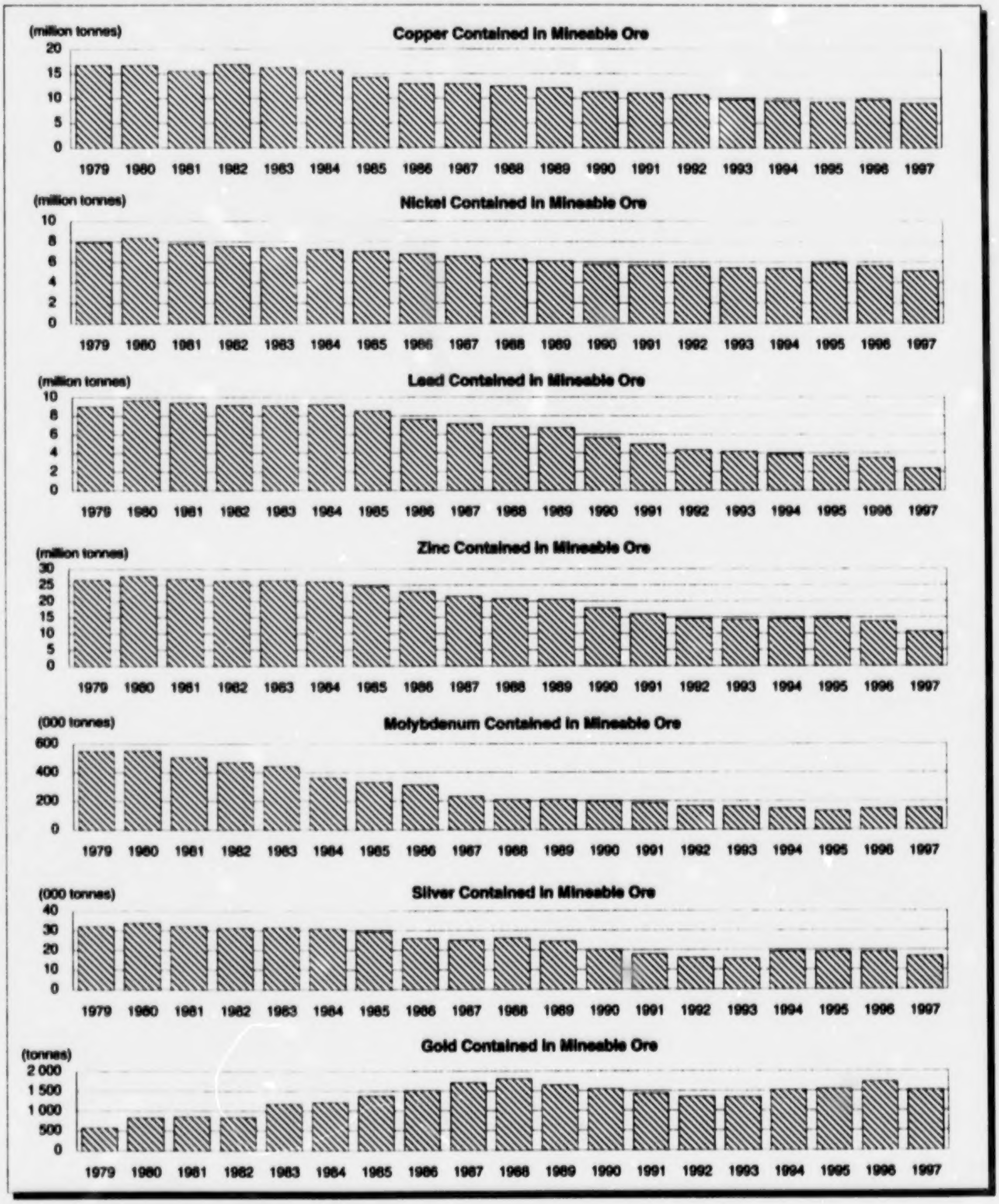
Outlook

Given that there were only two new production decisions announced in 1998, and that metal prices continued to decline during the year, it is highly probable that mine reserves of precious metals and base metals will decline further in 1999.

At the Voisey's Bay nickel-copper-cobalt deposit, Inco had established reserves and resources of 116 Mt at the end of 1998. If these figures are confirmed, Voisey's Bay will increase Canada's nickel reserves by about 28% and its copper reserves by about 9%.

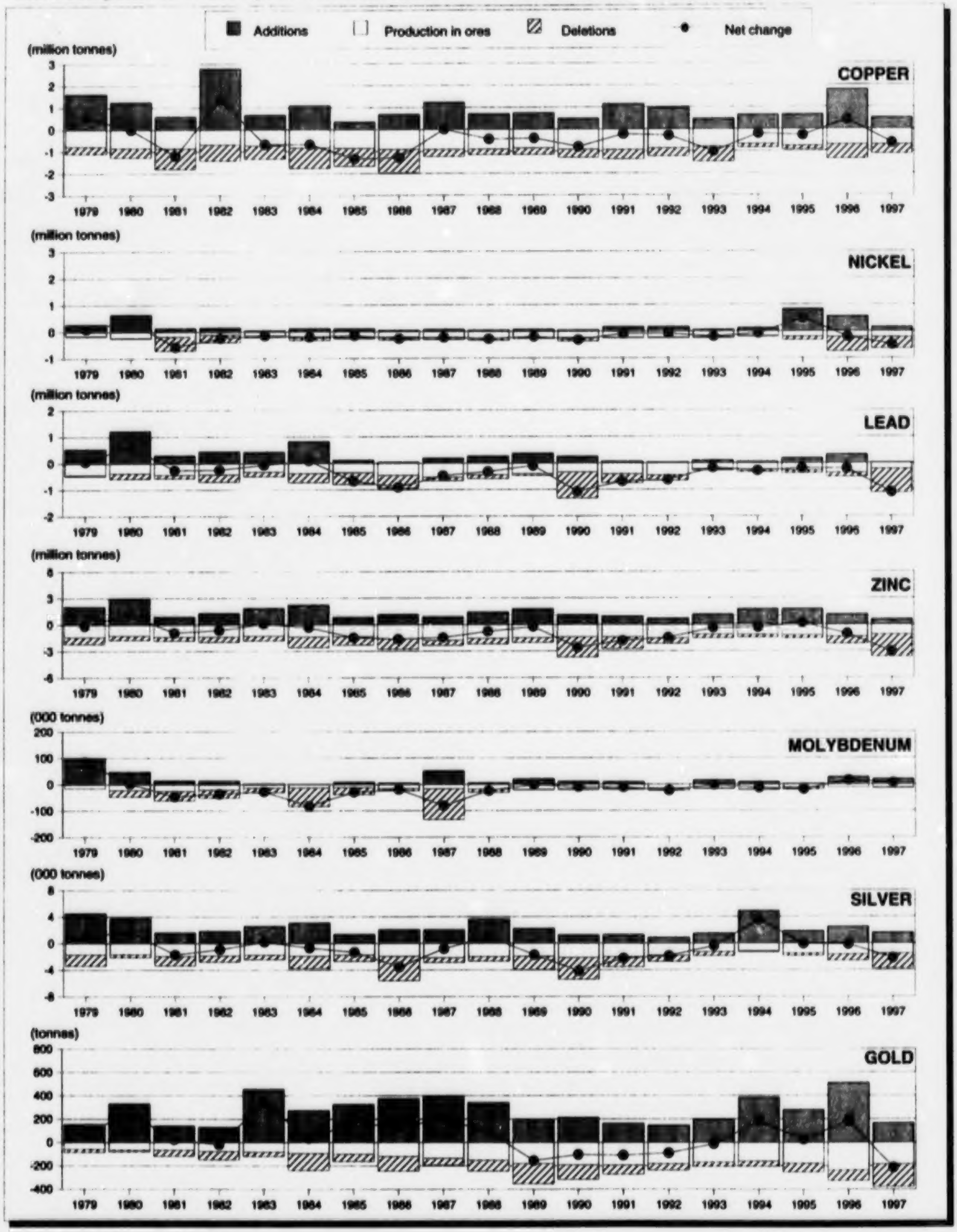
Note: Information in this review was current as of February 14, 1999.

Figure 2
Canadian Reserves of Selected Major Metals, 1979-97
Metal Contained in Proven and Probable Mineable Ore in Operating Mines and Deposits Committed to Production, as at December 31 of Each Year



Source: Natural Resources Canada, based on company reports and the Federal-Provincial Survey of Mines and Concentrators.
Note: This series was revised during 1996.

Figure 3
Main Components of Change in Canadian Reserves of Selected Major Metals, 1979-97



Source: Natural Resources Canada.

TABLE 1. MAIN COMPONENTS OF CHANGE DURING 1997 IN CANADIAN RESERVES OF SELECTED MAJOR METALS

Metal	Units	Revised Opening Metal Balance, January 1997	Metal in Ore Mined During 1997	Metal Apparently Written Off During 1997	Metal in New Reserves Found During 1997	Net Change During 1997	Closing Metal Balance, December 1997	% Change During 1997
Copper	000 t	9 667	–722	–409	496	–635	9 032	–6.6
Nickel	000 t	5 623	–231	–416	146	–502	5 122	–8.9
Lead	000 t	3 450	–232	–885	12	–1 106	2 344	–32.1
Zinc	000 t	13 660	–1 169	–2 470	567	–3 072	10 588	–22.5
Molybdenum	000 t	144	–14	–1	19	5	149	3.5
Silver	t	18 909	–1 582	–2 193	1 562	–2 212	16 697	–11.7
Gold	t	1 724	–186	–192	165	–214	1 510	–12.4

Source: Natural Resources Canada, based on company reports and the Federal-Provincial Survey of Mines and Concentrators.
Note: May not balance due to rounding.

TABLE 2. TONNAGES AND GRADES OF OPERATIONS INCLUDED IN CANADIAN RESERVES OF SELECTED MAJOR METALS, AS AT JANUARY 1, 1998

Tonnages classified by companies as "possible" are not included where they are reported separately from proven and probable tonnages, nor are tonnages for deposits for which there is no firm production decision. Data reported in imperial units were converted to metric units and rounded to the corresponding number of significant digits. Confidential data have been suppressed from the details of this report.

	Tonnes	Grade						
		Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
NEWFOUNDLAND								
Nugget Pond								
Richmont Mines Inc.								
Mineable	431 000							12.
NEW BRUNSWICK								
Brunswick No. 12 Underground								
Noranda Mining and Exploration Inc.								
Proven	43 653 000	0.33		3.61	9.08		104.	. .
Caribou								
Breakwater Resources Ltd.								
Proven and probable	5 838 000			4.0	7.3		96.	
Heath Steele								
Noranda Mining and Exploration Inc.								
Proven	546 000	0.95		1.55	5.49		60.	
Probable	1 494 000	0.66		1.84	6.66		75.	
QUEBEC								
Beaufor								
Aurizon Mines Ltd.								
Louvem Mines Inc.								
Proven	274 000						. .	7.8
Probable	484 000						. .	8.5
Bell Allard								
Noranda Mining and Exploration Inc.								
N/S	3 200 000	1.5			13.77		43.44	0.765
Bouchard-Hébert								
Cambior inc.								
Proven and probable	8 120 000	0.79			4.13		40.3	1.2
Bousquet No. 2								
Barrick Gold Corporation								
Proven and probable	3 442 000	. .					. .	8.19
Copper Mountain Oxide								
Noranda Mining and Exploration Inc.								
Probable	19 152 000	0.45						
Doyon								
Barrick Gold Corporation								
Cambior inc.								
Proven and probable	10 534 000						. .	6.9
Francoeur								
Richmont Mines Inc.								
Mineable	1 500 000						. .	6.5
Gallen								
Noranda Metallurgy Inc.								
Probable	1 650 000	0.23			4.74		27.	0.9
Joe Mann								
Campbell Resources Inc.								
Mineable	502 000	0.27					. .	8.16
Joubi								
Western Quebec Mines Inc.								
Proven and probable	60 740						. .	5.89
Kiena								
McWatters Mining Inc.								
Proven	2 393 000						. .	4.53
Probable	1 133 000						. .	4.33
Langlois								
Cambior inc.								
Proven and probable	6 179 000	0.52			8.72		40.2	0.1

TABLE 2 (cont'd)

	Tonnes	Grade Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
QUEBEC (cont'd)								
LaRonde								
Agnico-Eagle Mines Limited								
Proven	1 553 782	0.53			1.27		..	..
Probable	6 088 891	0.25			5.48		..	..
Louvicourt								
Aur Resources Inc.								
Novicourt Inc.								
Teck Corporation								
Mineable	10 700 000	3.48			1.59		27.4	0.86
Mouska								
Cambior inc.								
Stockpiles	10 046						..	14.94
Proven	84 224						..	16.33
Probable	125 500						..	15.48
Murdochville Townsite								
Noranda Mining and Exploration Inc.								
"E" Zone	1 209 000	3.38					16.48	..
Needle Mountain Open Pit								
Noranda Mining and Exploration Inc.								
..	..	..					..	
Raglan								
Falconbridge Limited								
Proven	6 515 000	0.89	3.38					
Probable	10 706 000	0.86	2.96					
Selbaie A1 Open Pit								
Billiton Metals Canada Inc. (Gencor Ltd.)								
Proven and probable	16 700 000	0.35		0.07	1.48		33.5	0.35
Sigma No. 1								
McWatters Mining Inc.								
Proven	2 188 000						..	5.05
Probable	1 358 000						..	5.51
Sleeping Giant								
Aurizon Mines Ltd.								
Cambior inc.								
Proven	228 000						..	10.6
Probable	347 000						..	12.8
Troilus								
INMET Mining Corporation								
Proven and probable	45 900 000	0.10					1.4	1.2
ONTARIO								
Aquarius								
Echo Bay Mines Ltd.								
Proven and probable	18 123 000							2.2
Campbell								
Placer Dome Inc.								
Proven and probable	4 193 000						..	16.5
David Bell								
Homestake Canada Inc.								
Teck Corporation								
Mineable	4 700 000						..	10.57
Detour Lake								
Placer Dome Inc.								
Proven and probable	2 016 000						..	3.4
Dome (including Paymaster)								
Placer Dome Inc.								
Proven and probable	32 880 000							1.7
Eagle River								
River Gold Mines Ltd.								
Proven and probable	1 164 000						..	10.91
Edwards								
River Gold Mines Ltd.								
VenCan Gold Corporation								
Proven and probable	156 100						..	12.09

TABLE 2 (cont'd)

	Tonnes	Grade Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
ONTARIO (cont'd)								
Falconbridge Sudbury Integrated Nickel Operations								
Falconbridge Limited								
Proven and probable	25 000 000	1.52	1.56					
Glimmer								
Exall Resources Limited								
Glimmer Resources Inc.								
Mineable	1 252 743							9.98
Golden Giant								
Battle Mountain Gold Company								
Proven and probable	8 087 000						. .	9.95
Holloway								
Battle Mountain Gold Company								
Teddy Bear Valley Mines, Limited								
Proven and probable	5 317 000						. .	6.53
Holt-McDermott								
Barrick Gold Corporation								
Proven and probable	3 199 000						. .	6.86
Hoyle Pond								
Kinross Gold Corporation								
Proven and probable	1 301 000						. .	10.54
Inco Ontario Division								
Inco Limited[1]								
. .	. .	. .	. .				. .	. .
Kidd Creek								
Falconbridge Limited								
Proven	20 673 000	2.90		. .	5.07		1.92	
Probable	11 710 000	1.82		. .	6.66		1.75	
Lac-des-Îles (palladium-platinum)								
North American Palladium Ltd.								
Proven and probable	7 200 000	. .	. .					. .
Macassa								
Kinross Gold Corporation								
Proven and probable	1 042 000						. .	12.45
Madsen								
Madsen Gold Corp.								
Proven and probable	506 471							11.1
Musselwhite								
Placer Dome Inc.								
TVX Gold Inc.								
Proven and probable	10 250 000							5.7
Red Lake								
Goldcorp Inc.								
Proven and probable	1 150 000						. .	19.4
Royal Oak Ontario Division								
Royal Oak Mines Inc.								
Proven and probable	26 571 000						. .	1.5
Williams								
Homestake Canada Inc.								
Teck Corporation								
Mineable	29 900 000						. .	5.14
Winston Lake								
INMET Mining Corporation								
Proven and probable	1 000 000	0.80			15.10		. .	. .
MANITOBA								
Bissett								
Rea Gold Corporation								
. .	. .						. .	. .

TABLE 2 (cont'd)

	Tonnes	Grade Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
MANITOBA (cont'd)								
Callinan								
Hudson Bay Mining and Smelting Co., Limited								
Proven	1 534 431	1.264			3.317		29.1	2.3
Probable	1 907 381	1.373			4.602		35.66	..
Inco Manitoba Division								
Inco Limited[1]								
..	..	..	..				..	..
Keystone								
Black Hawk Mining Inc.								
Mineable reserve	1 030 700						0.3	4.3
New Britannia (Nor-Acme/Snow Lake)								
High River Gold Mines Ltd.								
TVX Gold Inc.								
Reserves	4 040 000						..	4.7
Photo Lake								
Hudson Bay Mining and Smelting Co., Limited								
Proven	138 380	5.25			4.173		34.83	5.14
Probable	7 038	0.242			0.179		88.32	..
Ruttan								
Hudson Bay Mining and Smelting Co., Limited								
Proven and probable	..	..			..		..	..
Trout Lake								
Hudson Bay Mining and Smelting Co., Limited								
Proven	3 235 507	1.60			5.170		20.5	1.7
Probable	1 340 144	2.02			4.430		14.3	1.4
SASKATCHEWAN								
Contact Lake								
Cameco Corporation								
Uranerz Exploration and Mining Limited								
Proven (Bakos)	96 000						..	6.55
Probable (Bakos)	85 500						..	6.38
Seabee								
Claude Resources Inc.								
Proven and probable	590 000						..	9.98
BRITISH COLUMBIA								
Endako								
Nissho Iwai Corp.								
Thompson Creek Mining Company								
..	..					..		
Eskay Creek								
Prime Resources Group Inc.								
Proven and probable	1 356 000						2 680.	58.05
Gibraltar Dumps (biological leach cathode)								
Gibraltar Mines Limited								
..	..	..						
Gibraltar Open Pit								
Gibraltar Mines Limited								
..	..	..				..	..	
Golden Bear								
North American Metals Corp.								
Mineable (Ursa)	520 000							..
Mineable (Kodiak A)	473 000							..
Mineable (Kodiak B)	184 000							..

TABLE 2 (cont'd)

	Tonnes	Grade Cu	Ni	Pb	Zn	Mo	Ag	Au
		(%)	(%)	(%)	(%)	(%)	(g/t)	(g/t)
BRITISH COLUMBIA (cont'd)								
Highland Valley								
Cominco Ltd.								
Highmont Mining Company								
Rio Algom Limited								
Teck Corporation								
Proven and probable	497 000 000	0.42				. .	. .	. .
Huckleberry								
Mitsubishi Corporation, Dowa Mining Co., Ltd., Furukawa Co. Ltd. and Marubeni Corporation								
Princeton Mining Corporation								
Mineable proven and probable	88 800 000	0.513				0.014	2.8	0.062
Kemess South								
Royal Oak Mines Inc.								
Proven and probable	201 202 000	0.215						0.62
Mount Polley								
Imperial Metals Corporation								
Sumitomo Corp.								
Mineable	82 300 000	0.3						0.418
Myra Falls								
Westmin Resources Limited								
Proven and probable	8 058 000	1.60		. .	7.5		33.5	1.4
QR								
Kinross Gold Corporation								
Proven and probable	422 000						. .	5.23
Snip								
Prime Resources Group Inc.								
Proven and probable	210 000						. .	23.2
Sullivan								
Cominco Ltd.								
Proven and probable	7 100 000			4.0	7.2		23.	
YUKON TERRITORY								
Brewery Creek (heap leach)								
Viceroy Resource Corporation								
Proven	13 300 000						. .	1.44
Mount Nansen								
B.Y.G. Natural Resources Inc.								
. .	. .						. .	. .
NORTHWEST TERRITORIES								
Con								
Miramar Mining Corporation								
Proven and probable	2 434 000						. .	10.54
Giant Open Pit - Giant Underground								
Royal Oak Mines Inc.								
Proven and probable	844 000						. .	12.2
Lupin								
Echo Bay Mines Ltd.								
Proven and probable	1 831 000						. .	9.22
Nanisivik								
Nanisivik Mines Ltd.								
Proven and probable	3 460 000			0.4	8.2		36.	
Polaris								
Cominco Ltd.								
Pine Point Mines Limited								
Proven and probable	3 500 000			3.6	13.2			

Source: Natural Resources Canada, based on published company reports.
. . Not available in published reports or estimated by author; N/S Not specified.
[1] Inco Limited reports total Canadian ore reserves, including substantial reserves at Voisey's Bay, as 356 Mt grading of 1.58% nickel and 1.06% copper.
Notes: One tonne (t) = 1.1023113 short tons. One gram per tonne (g/t) = 0.02916668 troy ounces per short ton.

TABLE 3. PRODUCTION DECISIONS ADDED TO CANADIAN RESERVE TOTALS AS AT DECEMBER 31, 1997

Project	Operators and Major Partners	Province	Metals
There were no production decisions added to Canadian reserve totals during the year ending December 31, 1997.			

Source: Natural Resources Canada, based on company reports.

TABLE 4. CANADIAN RESERVES OF SELECTED MAJOR METALS BY PROVINCE AND TERRITORY, AS AT DECEMBER 31, 1997
Metal Contained in Proven and Probable Mineable Ore[1] in Operating Mines[2] and Deposits Committed to Production

Metal	Units[3]	Nfld.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	B.C.	Yukon	N.W.T.	Canada[5]
Copper	000 t	–	–	155	941	3 881	332	–	3 723	–	–	9 032
Nickel	000 t	–	–	–	537	3 406	1 179	–	–	–	–	5 122
Lead	000 t	–	–	1 842	10	52	–	–	304	–	136	2 344
Zinc	000 t	–	–	4 515	2 160	1 485	566	–	1 115	–	746	10 588
Molybdenum	000 t	–	–	–	–	–	–	–	149	–	–	149
Silver	t	–	–	5 263	2 294	3 159	401	0.3	5 424	23	133	16 697
Gold[4]	t	5	–	30	277	758	49	7	294	20	53	1 493

Source: Natural Resources Canada, based on company reports and the Federal-Provincial Survey of Mines and Concentrators.
– Nil or less than one unit.
[1] No allowance is made for losses in milling, smelting and refining. Excludes material classified as "possible." Includes "geological reserves" for some mines that do not report mineable ore. [2] Includes metal in mines where production has been suspended temporarily. [3] One tonne (t) = 1.1023113 short tons = 32 150.746 troy ounces. [4] Excludes metal in placer deposits because reserves data are generally unavailable. [5] May not balance due to rounding at the provincial level.

TABLE 5. CANADIAN RESERVES OF SELECTED MAJOR METALS BY INDUSTRY, AS AT DECEMBER 31, 1997
Metal Contained in Proven and Probable Mineable Ore[1] in Operating Mines[2] and Deposits Committed to Production

		Gold Mines	Copper, Copper-Zinc Mines	Nickel-Copper Mines	Zinc-Lead-Silver Mines	Molybdenum Mines	Miscellaneous Metal Mines	
	SIC no.[5]	0611	0612	0613	0614	0615	0619	Canada[6]
	(Units[3])							
Copper	000 t	86	5 302	3 419	219	–	7	9 032
Nickel	000 t	–	–	5 115	–	–	7	5 122
Lead	000 t	–	82	–	2 262	–	–	2 344
Zinc	000 t	353	4 127	–	6 108	–	–	10 586
Molybdenum	000 t	–	61	–	–	88	–	149
Silver	t	4 428	5 062	1 328	5 879	–	–	16 697
Gold[4]	t	1 142	244	65	40	–	2	1 493

Source: Natural Resources Canada, based on company reports and the Federal-Provincial Survey of Mines and Concentrators.
– Nil or less than one unit.
[1] No allowance is made for losses in milling, smelting and refining. Excludes material classified as "possible." Includes "geological reserves" for some mines that do not report mineable ore. [2] Includes metal in mines where production has been suspended temporarily. [3] One tonne (t) = 1.1023113 short tons = 32 150.746 troy ounces. [4] Excludes metal in placer deposits because reserves data are generally unavailable. [5] SIC Standard Industrial Classification. [6] May not balance due to rounding at the SIC level.

TABLE 6. CANADIAN RESERVES OF SELECTED MAJOR METALS AS AT DECEMBER 31 OF EACH YEAR, 1977-97
Metal Contained in Proven and Probable Mineable Ore[1] in Operating Mines[2] and Deposits Committed to Production

Year	Copper	Nickel	Lead	Zinc	Molybdenum	Silver	Gold[3]
	(000 t)	(000 t)	(000 t)	(000 t)	(000 t)	(t)	(t)
1977	16 914	7 749	8 954	26 953	369	30 991	493
1978	16 184	7 843	8 930	26 721	464	30 995	505
1979	16 721	7 947	8 992	26 581	549	32 124	575
1980	16 714	8 348	9 637	27 742	551	33 804	826
1981	15 511	7 781	9 380	26 833	505	32 092	851
1982	16 889	7 546	9 139	26 216	469	31 204	833
1983	16 214	7 393	9 081	26 313	442	31 425	1 172
1984	15 530	7 191	9 180	26 000	361	30 757	1 208
1985	14 201	7 041	8 503	24 553	331	29 442	1 373
1986	12 918	6 780	7 599	22 936	312	25 914	1 507
1987	12 927	6 562	7 129	21 471	231	25 103	1 705
1988	12 485	6 286	6 811	20 710	208	26 122	1 801
1989	12 082	6 092	6 717	20 479	207	24 393	1 645
1990	11 261	5 776	5 643	17 847	198	20 102	1 542
1991	11 040	5 691	4 957	16 038	186	17 859	1 433
1992	10 755	5 605	4 328	14 584	163	15 974	1 345
1993	9 740	5 409	4 149	14 206	161	15 576	1 333
1994	9 533	5 334	3 861	14 514	148	19 146	1 513
1995	9 250	5 832	3 660	14 712	129	19 073	1 540
1996	9 667	5 623	3 450	13 660	144	18 911	1 724
1997	9 032	5 122	2 344	10 588	149	16 697	1 510

Source: Natural Resources Canada, based on company reports and the Federal-Provincial Survey of Mines and Concentrators.
[1] No allowance is made for losses in milling, smelting and refining. Excludes material classified as "possible." Includes "geological reserves" for some mines that do not report mineable ore. [2] Includes metal in mines where production has been suspended temporarily. [3] Excludes metal in placer deposits because reserves data are generally unavailable.
Note: One tonne (t) = 1.1023113 short tons = 32 150.746 troy ounces.

Mineral Exploration, Deposit Appraisal and Mine Complex Development Activity in Canada

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New Definitions

To provide more complete and accurate coverage of mineral development expenditures in Canada from exploration to mine production, new definitions of work phases for mineral development were introduced in the 1997 federal-provincial survey of the mineral industry. Major changes include replacing the former exploration phase (broadly speaking) with the exploration (strictly speaking) and deposit appraisal phases and expanding the categories of expenditures covered.

The exploration phase now extends to the discovery and delineation of a mineral resource of potential economic interest. The deposit appraisal phase brings the delineated deposit to the stage of detailed knowledge required for a production feasibility study to support a production decision and undertake the mine complex development phase. Mine complex development includes mine development activities carried out to delineate the ore in detail, to gain access to and prepare it for production, and also to extend known reserves. An integrated survey format has been developed to collect statistical information for these three work phases.

In addition, new categories of engineering, economic and feasibility studies, and environment and land access expenditures have been added to field work and related overhead expenditures. Capital expenditures for construction, machinery and equipment, and associated repair and maintenance expenditures are now collected for all three phases instead of just for the mine development phase.

This year, to reconcile data for 1997 with previous statistical series, the data are adjusted to the old survey definitions by removing the new categories of expenditures. This review both compares the adjusted 1997 data with 1996 data and provides a detailed analysis of the 1997 data based on the new definitions. Tables 1a and 1b are the main reference tools provided to reconcile the 1997 data with those of 1996.

Highlights of Mineral Development Expenditures, 1997

In 1997, 753 project operators reported expenditures of $4.1 billion on the full spectrum of activities that are part of the exploration, deposit appraisal and mine complex development phases, as well as $1.6 billion on associated repair and maintenance expenditures, for a total of $5.7 billion (Table 2a).

The new categories of expenditures, collected for the first time in 1997, accounted for $361 million in expenditures, or 7% of the $5.7 billion total for 1997 (Tables 1a and 1b). The exclusion of these new categories from the 1997 data would have resulted in a total expenditure estimate of $5.3 billion, an increase of $300 million from 1996 and $600 million from 1995.

Exploration and deposit appraisal expenditures in Canada in 1997 amounted to $921 million. Exploration expenditures (strictly speaking) accounted for $634 million (69%) of this total and deposit appraisal expenditures were $287 million (31%) (Tables 1a and 2a). Total off-mine-site expenditures were $753 million (82%) and on-mine-site expenditures amounted to $168 million (18%).

To compare the 1997 exploration and deposit appraisal total with the 1996 exploration (broadly speaking) total, $101 million of previously unrecorded expenditures on engineering, economic and feasibility studies, the environment and land access expenditures must be removed. These exclusions would result in an estimate of $820 million for field work and overhead expenditures for 1997, down from the corresponding 1996 exploration total of $895 million. This constitutes a reduction of $75 million, or 8.3%, from 1996 to 1997. As shown in Table 2c, further declines are expected for 1998 and 1999.

Junior companies were responsible for one third of the exploration and deposit appraisal for field work

and overhead expenditures in 1997. Sixty-four of these companies spent $1 million or more, contributing 62% of the combined exploration and deposit appraisal expenditures for juniors. Field work and overhead expenditures by junior companies decreased by 15% from $315 million in 1996 to $267 million in 1997.

The search for diamonds has accounted for 10-20% of Canadian exploration and deposit appraisal expenditures annually from 1993 to 1998. Recently, field work and overhead expenditures for diamonds have declined from $154 million in 1996 to $92 million in 1997 and to $77 million in 1998. This decrease in diamond expenditures can be partially explained by a shift in spending from exploration to mine complex development at projects such as BHP's Ekati mine, which began production in October 1998.

Mine development expenditures totaled $866 million in 1997. With the new categories of expenditures totaling $32 million removed, this total is reduced to $834 million, a decline of 6% from the $884 million recorded in the 1996 survey.

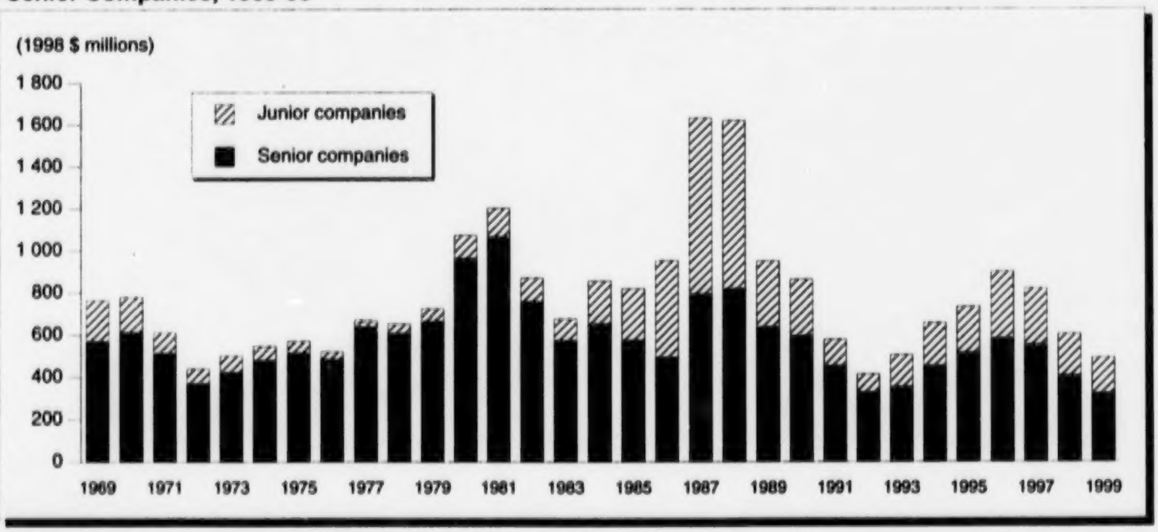
Environment-related expenditures are now collected in field expenditures and in capital, and repair and maintenance expenditures (Table 2b). By phase, the percentages of total expenditures directed to the environment in 1997 were 3.3% in the exploration phase, 5.4% in the deposit appraisal phase, and 1.5% in the mine complex development phase.

HISTORICAL PERSPECTIVE

Figure 1 depicts the historical trend in exploration plus deposit appraisal expenditures adjusted in constant 1998 dollars. After peak levels of exploration expenditures were reached in 1987 and 1988 (a result of the Mineral Exploration Depletion Allowance), exploration (broadly speaking) field work and overhead expenditures in Canada fell to a low of $412 million in 1992 (in constant 1998 dollars). From 1993 to 1996, higher metal prices and diamond and nickel-copper discoveries caused the level of activity to rebound by 118% to reach $896 million in 1996. While recent survey data indicate lower expenditure levels of $816 million for 1997 and $601 million for 1998, these amounts represent a level of activity comparable to that of 1991. Canada remains one of the world's top targets for mineral exploration.

The upward surge in expenditures since 1993 has been driven by important discoveries of diamond deposits in the Northwest Territories. In addition, the announcement of the nickel-copper-cobalt discovery at Voisey's Bay, Labrador, in late 1994 resulted in a flurry of exploration activity in the area and increased expenditures in 1995, 1996 and 1997.

Figure 1
Exploration Plus Deposit Appraisal for Field Work Plus Overhead Expenditures[1] by Junior and Senior Companies, 1969-99



Source: Natural Resources Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.
1 Includes on-mine-site plus off-mine-site activities.
Notes: Expenditures for 1997, 1998, and 1999 include both exploration plus deposit appraisal as per new definitions; up to and including 1996, most of the expenditures now included in the deposit appraisal work phase were reported under exploration (broadly speaking). Data for 1998 are preliminary; data for 1999 are forecast.

Intensive assessment drilling continues on mineralized zones at Voisey's Bay in Labrador. In August 1999, the project was released from further environmental assessment requirements following the review and revision of its environmental impact assessment.

The Bre-X incident in early 1997 had an adverse effect on exploration project financing. This event both preceded and accentuated the strong negative impact on expenditures caused by the Asian financial crisis and the dramatic drops in the prices of most metals that occurred at the end of 1997. In the first half of 1999, the persistence of these conditions and announcements of gold reserve sales by central banks depressed the price of gold to the US$250/troy oz level. However, the announcement in September 1999 of control measures on the sale of gold reserves by central banks should improve the outlook for the price of gold and may cause exploration expenditures to increase.

PRELIMINARY ESTIMATES, 1998, AND SPENDING INTENTIONS, 1999

Exploration and deposit appraisal field work and overhead expenditures declined by 27% to $601 million in 1998 from $820 million in 1997. Total expenditures in 1998, including the new categories, amounted to $678 million, compared to $921 million in 1997. Industry spending intentions (forecast) for 1999 show further declines to $489 million for field and overhead expenditures and to $581 million for total expenditures (Table 2c).

Exploration and deposit appraisal expenditures by junior companies in 1998 declined by 26% to $196 million (field work and overhead expenditures only) from their 1997 levels and are expected to decline by a further 14% to $169 million in 1999. Senior operators reported expenditures of $405 million in 1998, a decline of 27% from the $553 million reported in 1997.

Mine development expenditures in 1998 amounted to $1 billion, a figure that includes $32 million in expenditures in the new categories. This constitutes an increase of 16% from the $866 million reported in 1997.

Total field work, overhead and new expenditures on the three work phases amounted to $1.7 billion in 1998, 6% less than 1997 expenditures of $1.8 billion. Industry spending intentions for 1999 totaled $1.5 billion in expenditures, a further decrease of 11%.

Notes: (1) Information in this abbreviated review was current as of October 29, 1999.
(2) A more detailed analysis of mineral development activities in 1997 is available on the Internet at http://www.nrcan.gc.ca/mms/cmy/index_e.html or by contacting the author directly.

TABLE 1a. COMPARISON OF 1996 AND 1997 EXPENDITURES,[1] ON- AND OFF-MINE-SITE ACTIVITY FOR EXPLORATION, DEPOSIT APPRAISAL AND MINE COMPLEX DEVELOPMENT

Expenditure Category	1996					1997				
	Off-Mine-Site		On-Mine-Site		Total	Off-Mine-Site		On-Mine-Site		Total
	($ million)	(%)	($ million)	(%)	($ million)	($ million)	(%)	($ million)	(%)	($ million)
EXPLORATION										
Field work and overhead	n.a.	n.a.	n.a.	n.a.	n.a.	543.3	90.6	56.0	9.4	599.3
New expenditures[2]	n.a.	n.a.	n.a.	n.a.	n.a.	28.7	81.9	6.3	18.1	35.1
Subtotal	n.a.	n.a.	n.a.	n.a.	n.a.	572.0	90.2	62.4	9.8	634.4
Capital[3]	n.a.	n.a.	n.a.	n.a.	n.a.	25.2	97.9	0.5	2.1	25.7
Repair and maintenance[3]	n.a.	n.a.	n.a.	n.a.	n.a.	5.1	100	–	–	5.1
DEPOSIT APPRAISAL										
Field work and overhead	n.a.	n.a.	n.a.	n.a.	n.a.	123.8	56.1	97.1	43.9	220.8
New expenditures[2]	n.a.	n.a.	n.a.	n.a.	n.a.	57.2	87.0	8.5	13.0	65.7
Subtotal	n.a.	n.a.	n.a.	n.a.	n.a.	181.0	63.1	105.6	36.9	286.6
Capital[3]	n.a.	n.a.	n.a.	n.a.	n.a.	134.5	91.3	12.9	8.7	147.4
Repair and maintenance[3]	n.a.	n.a.	n.a.	n.a.	n.a.	23.0	45.3	27.8	54.7	50.8
EXPLORATION PLUS DEPOSIT APPRAISAL										
Field work and overhead	795.2	88.9	99.6	11.1	894.8	667.1	81.3	153.1	18.7	820.2
New expenditures[2]	n.a.	n.a.	n.a.	n.a.	n.a.	85.9	85.2	14.9	14.8	**100.8**
Subtotal	n.a.	n.a.	n.a.	n.a.	n.a.	753.0	81.8	168.0	18.2	921.0
Capital[3]	n.a.	n.a.	n.a.	n.a.	n.a.	159.7	92.2	13.4	7.8	**173.2**
Repair and maintenance[3]	n.a.	n.a.	n.a.	n.a.	n.a.	28.1	50.2	27.8	49.8	**55.9**
MINE COMPLEX DEVELOPMENT										
Field work and overhead	n.a.	n.a.	884.2	100	884.2	n.a.	n.a.	834.0	100	834.0
New expenditures[2]	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	31.5	100	**31.5**
Subtotal	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	865.5	100	865.5
Capital[3]	n.a.	n.a.	1 463.3	100	1 463.3	n.a.	n.a.	2 089.6	100	2 089.6
Repair and maintenance[3]	n.a.	n.a.	1 765.9	100	1 765.9	n.a.	n.a.	1 578.3	100	1 578.3
Total	n.a.	n.a.	5 007.6	100	5 007.6	n.a.	n.a.	5 683.5	100	5 683.5

Sources: Natural Resources Canada and Statistics Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.
– Nil; n.a. Not applicable.
[1] Up to and including 1996, most of the expenditures now included in the deposit appraisal work phase were reported under exploration (broadly speaking). [2] Includes engineering, economic and pre- or production feasibility studies, environment and land access expenditures. [3] Includes construction, and machinery and equipment expenditures, and related environmental protection and restoration expenditures.
Notes: Numbers may not add to totals due to rounding. Numbers in bold are the summary of newly collected data.

TABLE 1b. SUMMARY OF 1997 EXPENDITURES NOT PREVIOUSLY RECORDED

Expenditure Category	Total
	($ million)
EXPLORATION PLUS DEPOSIT APPRAISAL	
Environment	47.3
Engineering, economic and pre- or production feasibility studies	47.9
Land access	5.6
Subtotal	100.8
Capital	173.1
Repair and Maintenance	55.9
Total	329.8
MINE COMPLEX DEVELOPMENT	
Environment	12.2
Engineering, economic and pre- or production feasibility studies	17.0
Land access	2.3
Total	31.5
Grand total	361.3[a]

Sources: Natural Resources Canada and Statistics Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.
[a] May be underestimated if some environment expenditures in the capital, repair and maintenance categories were newly reported in 1997.
Note: See Tables 1a and 2a for more information.

TABLE 2a. EXPLORATION, DEPOSIT APPRAISAL AND MINE COMPLEX DEVELOPMENT EXPENDITURES[1], 1997

Expenditure Category	Exploration	Deposit Appraisal	Exploration Plus Deposit Appraisal	Mine Complex Development	Total
			($000)		
Field work and overhead[2]	599 336	220 839	820 175[a]	834 040	1 654 215
Engineering studies	3 617	25 872	29 489	15 997	45 486
Economic studies	1 069	1 450	2 519	42	2 561
Pre- or production feasibility studies	4 290	11 614	15 904	981	16 885
Environment	21 560	25 726	47 286	12 193	59 479
Land access	4 538	1 058	5 596	2 288	7 885
Subtotal	634 410	286 560	920 970	865 542	1 786 511
Off-mine-site[3]	572 027	180 951	752 979	n.a.	752 979
On-mine-site[3]	62 383	105 608	167 991	865 542	1 033 532
Capital[4]	25 716	147 435	173 151	2 089 640	2 262 792
Total	660 126	433 995	1 094 121	2 955 182	4 049 303
Repair and maintenance[4]	5 071	50 831	55 902	1 578 291	1 634 193
Grand total	665 197	484 826	1 150 023	4 533 473	5 683 496

Sources: Natural Resources Canada and Statistics Canada, from the Federal-Provincial Survey of Mining and Exploration Companies.
n.a. Not applicable.
[a] This total can be compared to some extent with exploration expenditures prior to 1997.
[1] Includes on-mine-site plus off-mine-site activities; exploration and deposit appraisal activities include only the search for and appraisal of deposits and do not include work for extensions of known reserves. [2] Overhead expenditures include mineral leases, claims and rental costs and project-related head office expenditures. [3] Amount of expenditures dedicated to off-mine-site and on-mine-site activities. [4] Includes construction and machinery and equipment expenditures.
Notes: Refer to Table 1b for the summary of expenditures not previously recorded. Numbers may not add to totals due to rounding.

TABLE 2b. SUMMARY OF ENVIRONMENT EXPENDITURES FOR EXPLORATION, DEPOSIT APPRAISAL AND MINE COMPLEX DEVELOPMENT, 1997

Expenditure Category	Exploration		Deposit Appraisal		Exploration Plus Deposit Appraisal		Mine Complex Development		Grand Total	
	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)
Environment										
Characterization	14 339	66.2	8 606	33.2	22 945	48.2	1 109	1.6	24 055	20.9
Permits	1 024	4.7	8 191	31.6	9 214	19.4	449	0.7	9 663	8.4
Protection	1 133	5.2	4 936	19.0	6 069	12.8	6 882	10.2	12 951	11.2
Restoration	5 064	23.4	3 994	15.4	9 057	19.0	3 752	5.5	12 810	11.1
Subtotal	21 560		25 726		47 286		12 193		59 479	
Capital, share of environment	81	0.4	126	0.5	207	0.4	27 034	40.0	27 241	23.6
Repair and maintenance, share of environment	5	0.0	98	0.4	102	0.2	28 392	42.0	28 494	24.7
Total environment	21 646	100.0	25 949	100.0	47 595	100.0	67 619	100.0	115 214	100.0
Total environment as a percentage of grand total[1]		3.3		5.4		4.1		1.5		2.0

Sources: Natural Resources Canada and Statistics Canada, from the Federal-Provincial Summary of Mining and Exploration Companies.
[1] Grand total refers to Table 2a.
Note: Numbers may not add to totals due to rounding.

TABLE 2c. EXPLORATION, DEPOSIT APPRAISAL AND MINE COMPLEX DEVELOPMENT EXPENDITURES,[1] 1998 AND 1999

Expenditure Category	Exploration		Deposit Appraisal		Exploration Plus Deposit Appraisal		Mine Complex Development		Grand Total	
	1998	1999	1998	1999	1998	1999	1998	1999	1998	1999
	($000)									
Field work and overhead[2]	469 800	378 189	131 340	110 379	601 140[a]	488 568[a]	972 062	872 514	1 573 202	1 361 062
Engineering, economic and pre- or production feasibility studies	7 002	4 681	39 753	56 719	46 755	61 400	14 229	22 371	60 984	83 771
Environment	14 257	7 214	11 556	11 144	25 813	18 358	16 871	17 100	42 684	35 458
Land access	2 016	1 430	2 150	11 655	4 166	13 085	1 156	1 847	5 322	14 932
Subtotal	493 075	391 512	184 799	189 897	677 874	581 409	1 004 318	913 832	1 682 192	1 495 242
Off-mine-site[3]	425 641	334 504	94 575	137 945	520 216	472 449	n.a.	n.a.	520 216	472 449
On-mine-site[3]	67 433	57 009	90 224	51 952	157 657	108 961	1 004 318	913 832	1 161 976	1 022 793
Capital[4]	1 901	2 587	80 801	64 152	82 702	66 719	1 103 426	1 069 908	1 186 128	1 136 627
$ for environmental protection and restoration[5]	59	12	303	287	362	299	27 254	28 452	27 617	28 752
Repair and maintenance[4]	227	1 001	24 342	25 570	24 569	26 571	1 207 515	1 165 195	1 232 084	1 191 766
$ for environmental protection and restoration[5]	123	165	704	704	827	869	88 190	142 958	89 017	143 827
Subtotal	2 128	3 589	105 143	89 722	107 271	93 291	2 310 941	2 235 103	2 418 212	2 328 393
Grand total	495 202	395 101	289 942	279 619	785 144	674 700	3 315 260	3 148 935	4 100 404	3 823 635
Total environment	14 439	7 391	12 563	12 135	27 002	19 526	132 316	188 511	159 318	208 037
Environment as a percentage of grand total	2.9	1.9	4.3	4.3	3.4	2.9	4.0	6.0	3.9	5.4

Sources: Natural Resources Canada and Statistics Canada, from the federal-provincial survey of mining and exploration companies.
n.a. Not applicable.
[a] This total can be compared to some extent with exploration expenditures prior to 1997.
[1] Includes on-mine-site plus off-mine-site activities; exploration and deposit appraisal activities include only the search for and appraisal of deposits and do not include work for extensions of known reserves. [2] Overhead expenditures include mineral leases, claims and rental costs and project-related head office expenditures. [3] Amount of exploration and deposit appraisal expenditures dedicated to off-mine-site and on-mine-site activities. [4] Includes construction, and machinery and equipment expenditures. [5] As part of capital expenditures or repair and maintenance expenditures.
Note: Numbers may not add to totals due to rounding.

Canadian Mineral Exploration and Discovery Analysis

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CANADA'S STANDING AS AN EXPLORATION TARGET

In 1997, exploration expenditures for non-petroleum minerals in Canada totaled $820.2 million. Canada remained one of the world's top targets (second after Australia) in terms of mineral exploration expenditures that year. Company exploration spending intentions were $767.4 million, gathered by a survey conducted early in 1998, but these were not met because of low gold and base-metal prices throughout most of 1998. The "preliminary" exploration total for 1998 (gathered early in 1999) is $601.1 million. Despite this decline, the Metals Economics Group's (MEG) 1998 survey (data that were gathered later in 1998) indicate that, in 1998, Canada remained in second place after Australia in terms of mineral exploration expenditures, with the United States continuing in third position. The relative rankings of these three countries have remained unchanged since 1992 (Figure 1). The United States has been consistently in third place since 1980.

However, the MEG exploration rankings do not adequately account for exploration expenditures in countries such as China and the various countries that have resulted from the breakup of the former Soviet Union. This is because MEG covers only exploration expenditures by the Western companies exploring in these countries. The value of Chinese non-petroleum mineral output is roughly five to six times that of Canada, so it may well be that the magnitude of the Chinese mineral exploration effort exceeds that in Canada or Australia.

The MEG survey has a cut-off exploration budget level of US$2.9 million; therefore, the survey has consistently and substantially underestimated the real levels of annual exploration spending in Canada and in Australia because both countries each have several hundred active junior exploration companies with exploration expenditures that are below that US$2.9 million cut-off. Aggregate exploration

Figure 1
Top Three Country Destinations of Mineral Exploration Capital from Worldwide Sources, 1973-98

Year	Rank: First	Second	Third
1998	Australia	**Canada**	United States
1997	Australia	**Canada**	United States
1996	Australia	**Canada**	United States
1995	Australia	**Canada**	United States
1994	Australia	**Canada**	United States
1993	Australia	**Canada**	United States
1992	Australia	**Canada**	United States
1991	**Canada**	Australia	United States
1990	**Canada**	Australia	United States
1989	**Canada**	Australia	United States
1988	**Canada**	Australia	United States
1987	**Canada**	Australia	United States
1986	**Canada**	Australia	United States
1985	**Canada**	Australia	United States
1984	**Canada**	Australia	United States
1983	**Canada**	Australia	United States
1982	**Canada**	Australia	United States
1981	**Canada**	Australia	United States
1980	Australia	**Canada**	United States
1979	Australia	United States	**Canada**
1978	Australia	United States	**Canada**
1977	United States	**Canada**	Australia
1976	**Canada**	United States	Australia
1975	United States	**Canada**	Australia
1974	**Canada**	United States	Australia
1973	Australia	United States	**Canada**

Source: Natural Resources Canada, based on official Canadian and Australian statistics and the best available data for the United States.
Notes: Australian expenditures were 6.5% higher than those for Canada in 1983 and 3.3% higher in 1991; however, correcting the reported Australian totals for substantial mine development expenditures, which are not included in Canadian statistics, ranks Canada first in 1983 and 1991. Complete data are not available for the former Soviet Union and China.

expenditures directed at Canada or Australia by these companies are substantial, and most likely are considerably in excess of the expenditures of junior companies in other individual countries worldwide. For this reason, the MEG survey exploration expenditure totals for Australia and Canada almost undoubtedly understate the exploration expenditures actually being directed at these countries relative to such expenditures in other countries.

RECENT MINERAL EXPLORATION AND DISCOVERY ACTIVITY AND RESULTS

Lower market prices for most metals, together with increased difficulty being experienced by junior companies in raising exploration funds, have resulted in a significant decline in exploration spending in Canada to $601 million (preliminary) in 1998, significantly lower than the $820 million of such expenditures in 1997. A further decline is anticipated in 1999. Company exploration spending intentions for 1999 (gathered early in 1999) total only $489 million.

Exploration for diamonds provided the most notable exploration successes in Canada in 1998 when at least eight new diamond deposits were discovered in the Northwest Territories. On the basis of small samples from these new deposits, it appears that they might be economically mineable, but larger bulk samples will be needed to more accurately measure diamond contents and diamond values.

DIAMOND EXPLORATION HIGHLIGHTS

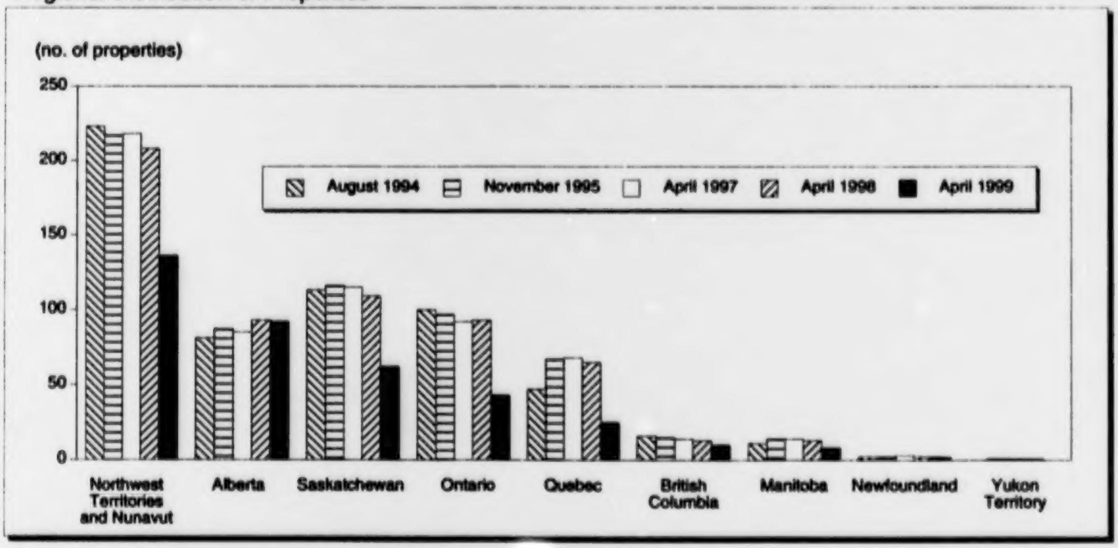
Introduction

In April 1999, there were some 378 diamond exploration properties in Canada (Figure 1). Although this number is considerably lower than the approximately 600 diamond exploration properties of each year from 1993 to 1998, the apparent decline has probably resulted from a change in the databases used to prepare the figure rather than from a marked decline in the number of diamond properties between April 1998 and April 1999. The most notable Canadian diamond exploration event in 1998 appears to have been the discovery of a gently dipping diamond-bearing dyke on a peninsula in Snap Lake in the Camsell Lake area of the Northwest Territories on a property owned by Winspear Resources Ltd. and Aber Resources Ltd. This deposit does not appear to be large (a few million tonnes in size) but, on the basis of a small bulk sample of 200 t, has yielded the highest per-carat and per-tonne diamond values known in any Canadian diamond deposit.

Ekati Diamond Mine

Production of diamonds from the Ekati mine property in the Northwest Territories began in October 1998. To the end of 1998, a total of 107 kimberlite pipes had been discovered (up from 100 pipes a year earlier) on the Core Block of the Ekati property

Figure 2
Exploration for Diamonds in Canada, 1994-99
Regional Distribution of Properties



Source: Natural Resources Canada, based on *MIN-MET CANADA* database for 1992-98 and *Info-Mine* database for 1999, ROBERTSON INFO-DATA Inc., Vancouver, British Columbia and used under licence.

(owned by BHP Diamonds Inc., 51%; Dia Met Minerals Ltd., 29%; Charles Fipke, 10%; and Stewart Blusson, 10%) or on the adjacent Buffer Zone claim block (owned by BHP Diamonds, 51%; Archon Minerals Limited, 31.2%; Charles Fipke, 10%; and Dia Met Minerals, 7.8%). Eighty-one of the 107 kimberlites lie on the Core Block of claims and the remaining 26 are on the Buffer Zone claims. Five diamondiferous kimberlite intrusions were discovered in 1998 on the Ekati property and Buffer Zone claims (Table 1). Bulk samples will be taken to better establish diamond contents and diamond values for these kimberlites.

The Jay pipe, on the Buffer Zone claims, is reported to be 7.7 ha in size with an estimated resource of 38.5 Mt. A 238-t sample, collected from the pipe in 1996, had an average grade of 2.01 ct/t valued at US$22.50/ct. At the end of 1998, a total of 36 potential kimberlite targets remained to be tested on the Core Block-Buffer Zone property.

Diavik Project

The Diavik project in the Northwest Territories is operated by Diavik Diamond Mines Inc., which owns a 60% interest. This company is a wholly owned subsidiary of Rio Tinto plc of London, England. The remaining 40% is held by Aber Resources Ltd. of Vancouver, British Columbia. Aber has put up 40% of the project costs and retains the right to market its 40% share of diamond production.

To the end of 1998, a total of 53 kimberlite pipes had been discovered on the Diavik property, 24 of which are known to be diamondiferous. Four pipes (A-154 South, A-154 North, A-418 and A-21) currently appear to have the greatest promise. A final feasibility study is scheduled to be completed for the Diavik property by mid-1999, at which time estimated capital and operating costs and a revised mining plan for the project are to be available. The proposed mine development plan includes the construction of dikes in Lac de Gras around the A-154 North and A-154 South kimberlites (which lie under the waters of Lac de Gras, adjacent to East Island) to permit open-pit mining of these deposits to begin in the second quarter of 2002. The A-418 dike is to be constructed in approximately 2007 and the A-21 pit is to be mined over a three-year period of approximately 2012-14. Underground mining of A-418 and A-154 South is to begin 12 to 14 years after start-up.

The feasibility study includes a range of production rates from 1.5 to 1.9 Mt/y, which would yield 6-8 Mct of diamonds annually during the period of maximum output from the open-pit mining phase.

The resource estimate total for the four pipes, to a depth of 400 metres, is 37.4 Mt containing 133 Mct of diamonds (Table 2). Estimated diluted mineable reserves from a prefeasibility study are 26 Mt containing 102 Mct at an average reserve grade of 3.9 ct/t. A 29-t mini-bulk sample, taken in 1998 from the A-11 pipe (10 km east of the proposed Diavik development site), yielded 7.6 ct of diamonds including a 3.01-ct, gem-quality stone, for an average grade of 0.262 ct/t. Exploration on the Diavik property is continuing, including additional drilling of two other diamondiferous kimberlite pipes.

AK-CJ Property

Four diamond deposits have now been discovered on the AK property, located some 150 km southeast of Lac de Gras in the Northwest Territories. The property was owned by Mountain Province Mining Inc., 90%, and Camphor Ventures Inc., 10%. These companies discovered the AK-5034 kimberlite pipe in 1996. The property has been optioned to Monopros Limited, the Canadian subsidiary of De Beers. Monopros can earn a 60% interest in the property by spending at least $18 million on bulk sampling, completing a bankable feasibility study, and advancing the project to commercial production.

In addition to the original AK-5034 pipe discovered by Mountain Province-Camphor Ventures, Monopros has discovered three additional diamond kimberlite deposits: the Hearn, Tuzo and Tesla pipes (Table 3). Early in 1999, Monopros used 12-inch drills to take four bulk samples totaling 1666 t, comprising 575 t from the 5034 pipe, 454 t from the Hearne pipe, 460 t from the Tuzo pipe and 177 t from the Tesla pipe. The samples are currently being processed and the results are expected in the summer of 1999. It is estimated that approximately 1000 ct of diamonds will be recovered from each of the 5034, Hearne and Tuzo pipes, sufficient to model grades and values per tonne for each of these pipes. The sample from the Tesla pipe is expected to yield approximately 65 ct of diamonds which, together with previously recovered diamonds from this pipe, will allow an improved estimate of the potential of this pipe.

Over the 1998/99 winter, a delineation program consisting of 16 diamond drill holes was carried out to better delineate the contacts of the kimberlites at depth to enable improved resource tonnage estimates to be calculated for the four pipes. Additional drilling during the same winter to test promising exploration targets resulted in the discovery by Monopros of a new pipe 12 km northeast of the above cluster of four pipes. At the time of writing of this chapter, no information was available concerning whether or not this pipe contains diamonds.

Jericho Project

Tahera Corporation, a company formed on February 28, 1999, by the merger of Lytton Minerals Limited and New Indigo Resources Inc., has found three diamondiferous kimberlites (JD/OD-1, JD/OD-3 and Contwoyto-1) on its Jericho Project property in Nunavut. A prefeasibility study concluded that the economics of the proposed JD/OD-1 project are marginal based on the established JD/OD-1 kimberlite resource alone, but could be considerably improved with the discovery of additional kimberlite resource tonnage. The 16.9 ct of diamonds recovered from the JD/OD-3 pipe included two diamonds weighing 1.18 ct and 0.75 ct. The joint-venture partners have no plans to evaluate the JD/OD-3 pipe further at this time due to its relatively low grade. Exploration for additional diamondiferous kimberlites continues in the immediate vicinity.

Ice Claims

Tahera Corporation reports that the Ranch Lake kimberlite pipe on the company's Ice claims in the Northwest Territories contains an estimated 57 Mt of kimberlite, to a depth of 300 m, with an average diamond content that is between 0.30 and 0.35 ct/t. The company states that the exploration philosophy of a joint-venture agreement with Kennecott Canada Exploration Inc. is to explore for higher-grade pipes that would improve the economics of the Ranch Lake property.

Snap Lake Project

A shallow-dipping, diamond-bearing dyke discovered at Snap Lake, in the Camsell Lake area of the Northwest Territories, on a property owned by Winspear Resources Ltd. (67.7%) and Aber Resources Ltd. (32.24%) has been yielding encouraging exploration results. Two 100-t bulk samples taken from surface yielded 226.72 ct (or 1.14 ct/t) of diamonds valued at US$301/ct (US$343/t). This is an exceptionally high value per carat. The 226.72 ct of diamonds include 25 stones that each weigh more than one carat with the three largest diamonds, which weigh 10.82, 8.42 and 6.04 ct, accounting for 75% of the value. The dyke, which has an average thickness of 2.4 m over an identified strike length of 1350 m, has been encountered in limited, widely spaced drilling as far as 2200 m to the east of its surface exposure and has been intersected by drilling over a distance of 2000 m in a north-south strike length. A scoping study has indicated that that portion of the dyke underlying the peninsula contains a resource of 1.3 Mt, of which 667 000 t are mineable by open-pit methods.

Winspear is attempting to identify a minimum of 3.5-5 Mt of kimberlite resource for a feasibility study, plus an equal tonnage of possible resources. A 6000-t bulk sample is to be collected from three separate sample sites during 1999. Winspear has also discovered three other shallowly dipping kimberlite dykes in Snap Lake that are similar in appearance to the above-noted diamond-bearing dyke, but there is no information available concerning whether these dykes are diamondiferous.

In March 1999, a dispute arose between Winspear and Aber concerning their ownership shares of the Snap Lake project, and it had not been resolved when this article was written.

Buffalo Hills

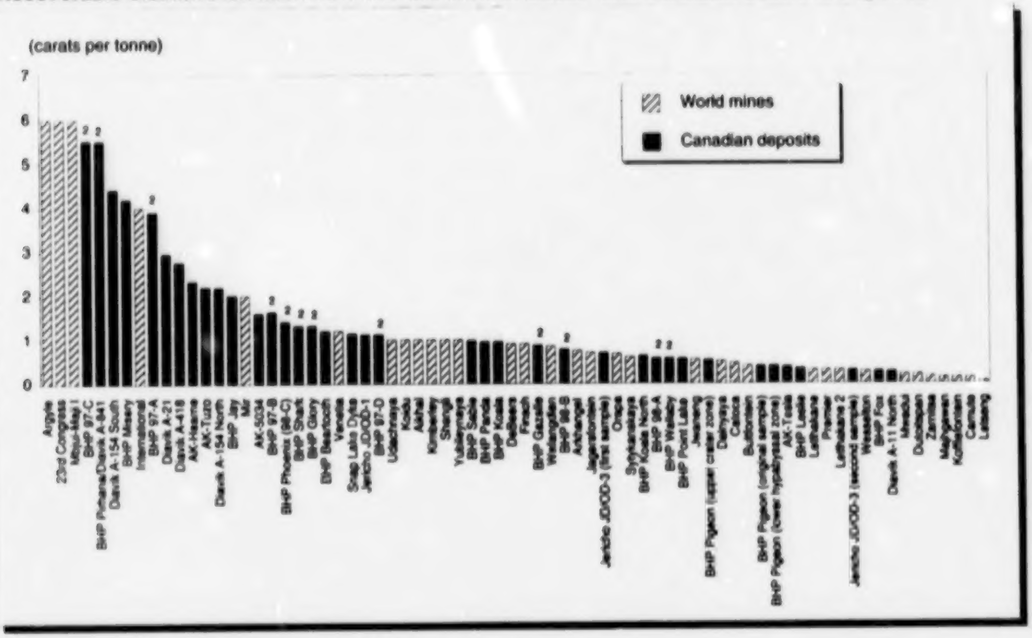
Ashton Mining of Canada Inc., with a 42.5% share, is the operator of a diamond exploration project in the Buffalo Hills of northwestern Alberta, about 250 km north-northwest of Edmonton. The other partners are Alberta Energy Company Ltd. (42.5%) and Pure Gold Resources Inc. (15%). Since early 1997, a total of 31 kimberlite intrusions have been discovered on this property, of which at least 19 contain diamonds.

A 479-t bulk sample of the K-14 kimberlite taken in March 1998 yielded 56.45 ct of diamonds at a grade of 0.118 ct/t. The two largest diamonds recovered weigh 0.90 and 0.88 ct respectively. The company considers the grade of 0.118 ct/t to be disappointing and is of the opinion that kimberlite K-14 would be unlikely to support a viable mining operation.

A mini bulk-sample of 18.68 t of kimberlite from the K-11 kimberlite yielded 0.82 ct (or 0.0441 ct/t), which is insufficient to be of economic interest. The company has not yet found any kimberlites of economic interest, but is continuing its exploration of the Buffalo Hills property.

Note: Information in this review was current as of April 30, 1999.

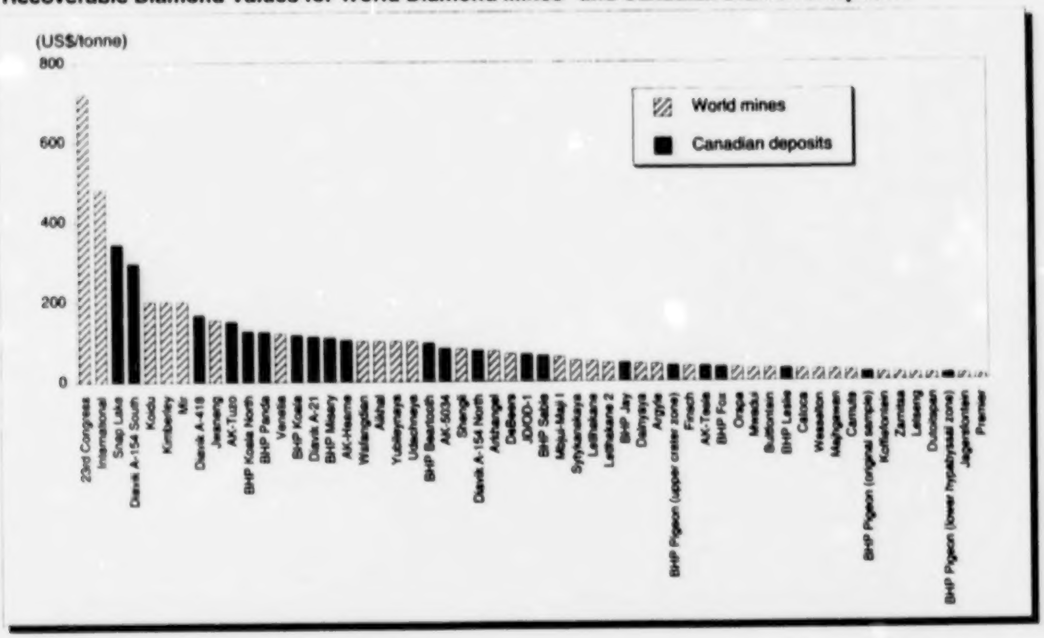
Figure 3
Recoverable Diamond Grades From World Diamond Mines[1] and Canadian Diamond Deposits



Source: Natural Resources Canada, based on published data.

[1] Grades of world diamond mines are based on data from the early 1990s. [2] Based on a sample weight of less than 0.5 tonnes.

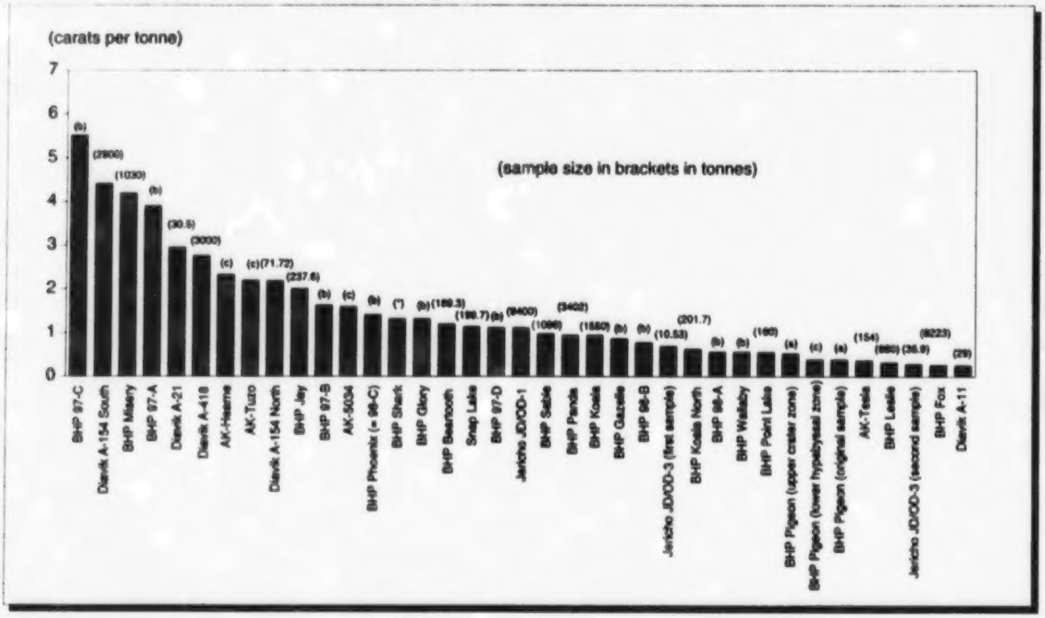
Figure 4
Recoverable Diamond Values for World Diamond Mines[1] and Canadian Diamond Deposits



Source: Natural Resources Canada, based on published data.

[1] Values for world diamond mines are based on data from the early 1990s.

Figure 5
Grades of Selected Canadian Diamond Deposits



Source: Natural Resources Canada, based on published data.
* Not available.
(a) Pigeon 1998 sample totalled 540 tonnes. Weights of the upper crater zone and lower hypabyssal zone portions of this sample were not published.
(b) Based on a sample weight of less than 0.5 tonnes. (c) Sample size not available.

TABLE 1. SELECTED DATA ON CANADA'S MOST PROMISING DIAMOND DEPOSITS

Pipe	Total Tonnes Sampled	Total Carats Recovered	Average Grade (carats/tonne)	Average Value (US$/carat)	Average Value (US$/tonne)
EKATI MINE AND BUFFER ZONE PROPERTIES					
Panda	3 402	3 244	0.95	130	124
Misery	1 030	4 313	4.19	26	109
Koala	1 550	1 465	0.95	122	116
Koala North	201.7	126.58	0.63	200	126
Fox	8 223	2 199	0.27	125	34
Leslie	680	233	0.33	89	29
Pigeon (original sample)	154	60	0.39	51	20
Pigeon (1998 sample)	540	..	..	..	..
Upper crater zone	213.6	113.89	0.53	71	38
Lower hypabysal zone	351.2	137.42	0.39	39	15
Jay	237.6	476.8	2.01	33	45
Sable	1 096	1 070	0.98	64	63
Beartooth	189.3	227.09	1.20	79	95
Point Lake	160	90+	0.56	..	..
97-A	0.0669	0.261	3.90	..	..
97-B	0.4070	0.662	1.63	..	..
97-C	0.0572	0.316	5.52	..	..
97-D	0.232	0.260	1.12	..	..
98-A	0.1949	0.112	0.57	..	..
98-B	0.0733	0.057	0.78	..	..
Phoenix (98-C)	0.2395	0.338	1.41	..	..
Shark	..	..	1.32	..	..
Gazelle	0.4834	..	0.87	..	..
Glory	0.2438	..	1.32	..	..
Wallaby	0.1208	..	0.57	..	..
Piranha (also known as Diavik A-841) (straddles boundary of Buffer Claims and Diavik Property)	0.057	..	5.51	..	..
DIAVIK PROPERTY					
A-154 South	2 900	12 800	4.41	67	296
A-154 North	71.72	156.81	2.19	35	77
A-418	3 000	8 275	2.76	56	166
A-21	30.5	90	2.95	38	112
A-11 North	29	7.6	0.26	..	..
JERICHO PROPERTY					
JD/OD-1	9 400	10 539	1.12	60	67
JD/OD-3 (first sample)	10.53	7.34	0.697[a]	..	..
JD/OD-3 (second sample)	35.9	10.41	0.29	..	..
AK PROPERTY					
5034	..	..	1.6	51	82
Hearne	..	..	2.33	44	103
Tuzo	..	..	2.2	68	150
Tesla	..	..	0.37	96	36
SNAP LAKE PROPERTY					
Snap Lake Dyke	199.7	226.7	1.14	301	344

Source: Natural Resources Canada, based on company data.
.. Not available.
[a] Includes a single 3.6-ct stone; if this stone is excluded, the grade is 0.25 ct/t.

TABLE 2. DIAVIK PROJECT RESOURCE ESTIMATES

Unit	A-418 Pipe	A-154 South Pipe	A-154 North Pipe	A-21 Pipe	Total/Average
Resources (million tonnes)	9.0	12.0	11.5	4.9	37.4
Grade (ct/t)	3.7	4.8	2.4	3.0	3.5
Total (millions of carats)	33	57	28	15	133

Source: Natural Resources Canada, based on company data.

TABLE 3. ESTIMATED RESOURCES OF AK PROPERTY DEPOSITS

Pipe	Tonnage	Average Grade	Value Per Carat	Value
	(million tonnes)	(carats/tonne)	(US$)	(US$/tonne)
5034	15	1.6	51	82
Hearne	8	2.33	44	103
Tuzo	9	2.2	68	150
Tesla	4	0.37	96	36

Source: Natural Resources Canada, based on company data.

Canadian Mine Openings, Closings, Expansions, Extensions and New Mine Developments

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Overview

The current metal downturn that began with a dramatic drop in the price of gold in late 1996 continued in 1998, causing more mines to close than open. During the year, 9 mining operations came on stream (including 5 new mines and 4 re-openings) and 17 mines closed (including 8 closures and 9 suspensions) (Tables 1 and 2). The 5 new mines consisted of 1 gold-copper mine, 1 copper-zinc mine, 2 industrial mineral mines and, for the first time in Canadian history, a diamond mine. The re-openings included 3 gold mines and 1 coal mine. The 17 mine closings included the production suspension at 2 gold mines, 6 base-metal mines and a wollastonite mine, and the permanent closure of 3 gold mines, 4 base-metal mines and an iron mine. Four of the mine openings (2 new mines and 2 re-openings) and 6 of the mine closings involved Canadian and foreign joint ventures or were foreign-controlled operations. In addition, 6 Canadian junior companies joined the rank of producer in Canada in 1998.

The new mines opened in 1998 were: the Collier Point barite mine in Newfoundland, the Konuto Lake (Denare Beach) copper-zinc mine in Saskatchewan, the Kemess South (also commonly referred to as Kemess) gold-copper mine and the Cassiar asbestos tailings operation in British Columbia, and the Ekati diamond mine in the Northwest Territories. Mines re-opened during the year included the Madsen gold mine in Ontario, the Bissett (formerly San Antonio) gold mine in Manitoba, the Costello coal mine in Saskatchewan, and the Blackdome gold mine in British Columbia.

The most important new mines in 1998, in terms of value of expected production and employment, were Kemess in British Columbia and Ekati in the Northwest Territories. Significant re-openings were Madsen in Ontario, Bissett in Manitoba, and Costello in Saskatchewan. In addition, the zinc circuit at the LaRonde gold-zinc mine in Quebec was brought on stream. The 52 000 t/y of zinc output capacity provided by the zinc circuit is equivalent to a significant new zinc mine in the province.

Eight significant mines closed during 1998. In Ontario, the Shebandowan nickel-copper mine near Thunder Bay closed in the second quarter; the Whistle mine, also a nickel and copper producer, at Sudbury closed in the summer; and the Winston Lake zinc-copper mine near Schreiber closed in December. All three closures were due to low metal prices and high costs. As well, the George MacLeod iron mine near Wawa closed in May due to high costs and a resulting lack of competitiveness, while the Photo Lake copper-zinc mine near Snow Lake, Manitoba, closed in September and the Contact Lake gold mine near La Ronge, Saskatchewan, closed in June, both as a result of ore depletion. In British Columbia, the QR gold mine near Quesnel closed in April due to declining gold prices and high production costs. The Klondike mine, a significant placer operation near Dawson City, Yukon, closed in January due to the depletion of economic ore reserves.

In addition to these production suspensions and mine closures, numerous production cutbacks and project postponements that started in 1997 continued throughout 1998 as metal prices declined further, creating substantial employment losses in the year. Job losses through production cutbacks amounted to at least 700 in 1998, the largest such losses since 1991/92 when 65 mines closed.

Despite weak metal prices, there were at least 12 metal mine expansion and mine extension projects of significance across Canada in 1998 (Table 2). Most of these projects marked the continuation of existing programs that began in recent years, but several were further expansions or extensions and one was a new announcement. The more important of these existing programs were the Carol Lake and Wabush Mines iron ore operations in Labrador; the Copper Rand 5000 gold-copper project, and the Doyon, Joe Mann, Kiena, LaRonde and Sigma (the Sigma-Lamaque complex) gold mines in Quebec; and the

Campbell and Red Lake gold mines, as well as the McCreedy East nickel-copper mine, in Ontario. The most significant new expansion and extension program announced in 1998 was at the Creighton nickel-copper mine in Ontario.

Although fewer mines came on stream in 1998 than in 1997, the total capital cost for new and re-opened mines in 1998 is estimated to have been more than $1.4 billion, marginally lower than the $1.5 billion for those opened in 1997. This relatively high level of capital cost for mines opened in 1998 mostly represents the capital investment for developing two large mines: the Kemess South gold-copper mine in British Columbia and the Ekati diamond mine in the Northwest Territories. At least another $250 million is estimated to have been spent on mine expansions and extensions, about the same as in 1997. Preliminary estimates indicate that average annual capital spending will be lower in 1999, 2000 and 2001, but will likely still be in the neighbourhood of $800 million to $1 billion. Capital investment is expected to increase in the year 2002.

Regional Perspective

During 1998, as in 1997, seven provinces and both territories were affected by mine openings or closings. New Brunswick, Ontario and the Yukon were particularly hard hit as mine closings exceeded mine openings, resulting in large net losses in ore capacity and employment. Of the 9 mine openings in the year, 5 were new mines. These include 2 in British Columbia and 1 in each of Newfoundland, Saskatchewan and the Northwest Territories. In addition, 1 mine re-opened in each of Ontario, Manitoba, Saskatchewan and British Columbia. Of the 17 mine closings, 4 mine closures occurred in Ontario and 1 in each of Manitoba, Saskatchewan, British Columbia and the Yukon. As well, 2 suspensions occurred in each of New Brunswick, the Yukon and the Northwest Territories, and 1 in each of Newfoundland, Quebec and British Columbia. However, because the opening or closure of a larger mine will have more effect on production and employment than that of a smaller mine, the impact of mine openings and closings varied considerably from province to province. Overall, Saskatchewan and British Columbia benefitted the most from mine openings, while Ontario, New Brunswick and the Yukon were the hardest hit by mine closures or production suspensions at relatively large mines. The social and economic benefits from the opening of the Ekati diamond mine in the Northwest Territories were reduced by the temporary closings of two significant gold mines: the Lupin and the Con mines. The Con mine has since re-opened, in May 1999, and the Lupin mine is currently expected to re-open in 2000.

In Newfoundland, the small Collier Point barite mine near Trinity Bay was opened in the summer by Phoenix Minerals Corporation and Newfoundland Barite Ltd. Full capacity is 10 000 t/y of barite product. The mine is Newfoundland's first barite producer to supply the east coast drilling industry in recent years. Production was suspended at the Beaver Brook antimony mine near Glenwood in February, after 14 months of operation, due to poor market conditions. As a result, the province incurred net losses of 575 t/d of ore production capacity and 70 mining jobs. The Nugget Pond mine near Baie Verte, the only operating gold mine in the province, produced 44 000 oz of gold in 1998 at an estimated cash cost of about US$148/oz, one of Canada's lowest-cost gold mines.

In New Brunswick, production at both the Caribou and Restigouche zinc-lead-silver-gold mines was suspended in August due to low metal prices and low metal recoveries. With no mine openings, the province suffered net losses of 3000 t/d of ore capacity and some 280 mining jobs. Only a year ago, the province lost its 10 500-t/d Potacan potash mine and 550 mining jobs due to irreversible flood damage. The Caribou mine near Bathurst, dormant since October 1990, was last re-opened in August 1997, along with the new Restigouche mine nearby. Since the suspensions, owner Breakwater Resources Ltd. has conducted technical and economic studies to determine the possibility of re-opening both mines. The conclusion is that in addition to the need for higher metal prices, the primary grinding and flotation capacities will have to be increased and a re-opening feasibility study is under way.

In Quebec, there was one mine suspension and no mine openings in 1998. At Lac-Saint-Jean, the 550-t/d St. Onge wollastonite mine suspended operations in June due to low wollastonite prices and the need to modify production objectives. About 20 of the 75 mine workers were kept on site to prepare for re-opening in the summer of 2000. A new zinc circuit was brought on stream in September 1998 at the LaRonde gold-zinc mine near Val-d'Or. The circuit has an estimated 2450 t/d of zinc ore capacity, with planned output of 52 000 t/y of zinc, a significant addition to zinc production capability. In 1998, the LaRonde mine produced 150 000 oz of gold. The value of the zinc to be produced will equal that of gold, and the design capacity will double mine revenues by the summer of 1999. From its mine openings and closings in 1998, Quebec incurred net gains of some 1900 t/d of ore production capacity and no employment losses.

In Ontario, one mine re-opened and four closed. The 500-t/d Madsen gold mine near Red Lake resumed production in July. Production first began in 1938 and ceased in 1976. The mine was redeveloped and re-opened by Madsen Gold Corp. in June 1997, but was soon put on care and maintenance due to low gold prices. Claude Resources Inc. of Saskatoon

acquired Madsen Gold in April 1998 and resumed mining, focusing on the Austin and McVeigh zones. Ore from the McVeigh zone is expected to boost ore throughput to 725 t/d from 500 t/d in 1999.

Three of the four mine closures in Ontario in 1998 were base-metal mines. These include the Shebandowan mine near Thunder Bay in the second quarter and the Whistle mine in Sudbury in the summer. Both were nickel-copper producers that were closed because of low metal prices and high costs. Production at the Winston Lake zinc-copper mine, near Schreiber, was suspended in December 1998 and, in February 1999, the company decided to close the mine permanently as further developing the nearby Pick Lake deposit would not yield a profitable operation. The George W. MacLeod iron mine near Wawa closed in May due to high costs and a lack of competitiveness. This marked the end of iron mining in the province. Ontario thereby incurred net losses of some 8100 t/d of ore production capacity and some 430 mining jobs.

In Manitoba, one mine re-opened and one closed in 1998. The 900-t/d Bissett (formerly San Antonio) gold mine northeast of Winnipeg was reactivated for production in June. The mine was last re-opened in July 1997 by Rea Gold Corporation, with production suspended six months later when Rea Gold went bankrupt. In the spring of 1998, Harmony Gold (Canada) Inc., a South African-controlled company, acquired the Bissett mine and resumed production in June. The 500-t/d, high-grade Photo Lake copper-zinc mine near Snow Lake, where production began in mid-1995, closed in September due to ore depletion. All employees at the mine were relocated to the company's new mine at Konuto Lake, Saskatchewan, 120 km west of Snow Lake.

In Saskatchewan, two mines opened and one closed in 1998. The 600-t/d Konuto Lake (also known as Denare Beach) copper-zinc mine near Creighton, Saskatchewan, came on stream in September and is expected to produce 5500 t of copper and 1500 t of zinc annually. The Costello coal mine near Estevan re-opened in January. The mine was redeveloped to replace the nearby Utility mine, which is expected to be mined out in early 1999. Annual production at Costello will be 2.3 Mt of lignite A, sufficient for more than 30 years' supply to the nearby Saskatchewan Power Corporation's power plant at Estevan. The mine is part of the Boundary-Dam East mining complex, which combines the Costello and Shand mines.

The Contact Lake gold mine, near La Ronge, closed in June due to ore depletion after three and a half years of production. In 1998, it produced 29 000 oz of gold at a cash cost of US$170/oz, making it one of Canada's lowest-cost gold producers. Overall, Saskatchewan fared best among all provinces and territories in 1998 with net gains of nearly 8100 t/d of ore capacity and 225 mining jobs.

After a considerable struggle with financing, the 40 000-t/d Kemess South gold-copper mine in central British Columbia came on stream in May 1998, creating 350 mining jobs. Developed at a capital cost of $470 million, the mine is the largest new mine in Canada since the Highland Valley Copper mine, which was formed over a long period of time by combining several mines, also in British Columbia. Planned annual production from Kemess was 250 000 oz of gold and 60 million lb of copper. Financial difficulties continued to plague the operation after start-up, a result of declining gold and copper prices and cost overruns caused by unforeseen construction-related problems. In February 1999, owner and operator Royal Oak Mines Inc. sought bankruptcy protection and subsequently went into receivership in April. The mine is currently being operated by the receiver, PricewaterhouseCooper Ltd. until it can be sold to help satisfy the company's $665 million debt.

During 1998, in northern British Columbia, the Cassiar asbestos mine tailings operation was brought on stream in July to process asbestos tailings left from the former Cassiar mine, which closed in 1989 due to ore depletion. In 1998, production was an estimated 4000 t of chrysotile fibre, and is expected to increase to 10 000 t in 1999. The 17 Mt of mine tailings (4.5% asbestos fibre) are estimated to be sufficient for 13 years of production. In addition, there was 6 Mt of stockpiled ore grading 5-6% asbestos. Tailings were reprocessed by a dry mill in 1998 but a wet mill is to be constructed in 1999. There is good potential to reactivate the nearby McDame underground asbestos mine for production in the future, and there is also a plan to build an on-site test plant to extract magnesium from asbestos tailings.

The 180-t/d Blackdome gold mine near Clinton re-opened in October 1998. Economic ore had been mined out by December 1990 and the mine closed, but continued exploration has led to the discovery of additional high-grade ore. Redevelopment of the mine began in 1997, and the mine is expected to produce 12 000 oz of gold annually. The 1000-t/d QR underground gold mine near Quesnel closed in April 1998 after less than three years of production due to high costs, lower-than-expected grades, and declining gold prices. About 90 workers were laid off. Mining had begun as an open-pit operation, which was completed in 1997, and then shifted to underground. The majority of the reclamation work is scheduled for completion in 1999.

Production was suspended at the 4000-t/d Myra Falls underground mine near Campbell River in mid-December due to ground problems within the Battle and Gap zones. Poor ground conditions had resulted in higher dilution and lower head grades. About 270 of the 360 workers were kept on site during the suspension to carry out remedial and development work,

and the mine was successfully re-opened on April 1, 1999. Overall in 1998, British Columbia incurred net gains of some 35 000 t of daily ore production capacity and 30 mining jobs.

The Yukon's economy suffered a serious blow in 1998 as three mines closed and no mines opened. Production at the 12 000-t/d Grum and Vangorda zinc-lead-silver mines at Faro was suspended in January after three months of shaky operation since the most recent re-opening in October 1997. The mine closures occurred when Anvil Range Mining Corporation, the majority owner and operator, went into receivership. All 386 workers were laid off. Low grades, high costs and low metal prices have rendered the mines uneconomic. As well, the 1500-t/d Klondike gold mine near Dawson City, a significant placer gold operation in the territory, ceased production in January due to the depletion of ore reserves. As a result, the Yukon ended 1998 with a 13 500-t/d reduction in ore capacity and some 400 fewer mining jobs, a loss of about three quarters of territorial mining revenue and jobs.

In the Northwest Territories, Canada's first diamond mine, the Panda open-pit mine at Lac de Gras, opened in October. Panda is one of five diamondiferous kimberlite pipes currently scheduled for production at the Ekati diamond mining complex. The five pipes, Panda, Misery, Koala, Sable and Fox, are to be developed as five separate mines between 1998 and 2008. Ore production from the Panda pit will reach 9000 t/d in 1999, with an annual diamond production of 3 Mct of gem-quality diamonds. By 2008, all five pipes will be in production with ore throughput expected to double to 18 000 t/d and diamond production to double. The capital cost of developing these five pipes has been estimated at US$700 million. Although 78 Mt of ore are scheduled to be mined over a 17-year initial mine life, the five pipes have combined ore reserves and additional resources of 133 Mt. In addition, several diamondiferous pipes have been discovered on the property, including three that are in the vicinity of the Panda pit, namely the Koala North, Beartooth and Pigeon, and these could become additional sources of ore for the Panda mill. Therefore, the overall mine life of the Ekati operation could exceed 25 years. The Ekati mining complex is expected to create 830 mining jobs. Currently, 650 jobs have been created at Panda.

Elsewhere in the Northwest Territories, production at both the 810-t/d Con gold mine at Yellowknife and the 2085-t/d Lupin gold mine at Contwoyto Lake were suspended in 1998, affecting 840 mine workers. The net result of mine openings and closures in the Northwest Territories was a net gain of 6100 t/d of ore production capacity but a net loss of 190 mining jobs. Fortunately, the Con mine re-opened after the strike at the mine ended in May 1999. As well, based on a recent study by Echo Bay Mines Ltd., the Lupin mine, which was closed due to high costs and low gold prices, could be re-opened in 2000 under a new mining schedule and cost structure.

Mine Expansions and Extensions

Despite low metal prices, at least 12 significant gold and base-metal mine expansion and extension projects were initiated or undertaken in 1998 (Table 2): 6 in Quebec, 5 in Ontario, and 1 in Saskatchewan. The majority of these projects involved the completion of existing programs and several further extensions at gold mines.

In Quebec, as new ores continued to be found at depth and in the vicinity of mine sites, expansion and extension programs at the Doyon, Joe Mann, Kiena, LaRonde and Sigma mines were extended beyond originally scheduled completion dates. Deep ore development progressed well at the Copper Rand 5000 project, but production start-up has now been rescheduled to the year 2001. The most important production expansions and mine life extensions occurred at the Doyon and LaRonde mines. Early in 1998, Cambior inc. acquired the other 50% interest in the Doyon mine (at Cadillac) from Barrick Gold Corporation. Cambior now owns 100% of the mine and has become the operator. During 1998, Cambior's Mouska gold mine was integrated with the Doyon mine to form the Doyon Division. At the start of 1999, ore reserves at the Doyon Division stood at 11.1 Mt grading 7.4 g/t gold, or a total of 2.6 million oz of gold. Gold production at Doyon in 1998 was 239 600 oz at a cash cost of US$226/oz. In 1999, production is forecast to be 260 000 oz at a cash cost of US$200/oz. In 1998, capital development at the mine totaled $26 million, with another $25 million planned for 1999 that includes the sinking of an internal shaft at Mouska and further underground exploration and development at both Mouska and Doyon. The $256 million, four-year expansion and extension program at the LaRonde gold mine at Val-d'Or, which began in 1997, continued in 1998. Besides the development of new ore zones discovered in recent years, the program includes shaft sinking and mill expansion. Gold production at LaRonde was 150 000 oz in 1998 at a cash cost of US$213/oz. By 2001, the mine is expected to produce 220 000 oz of gold at an average cost after zinc, copper and silver credits of US$125/oz, making LaRonde one of the lowest-cost gold mines in Canada.

In October 1998, the Iron Ore Company of Canada announced a $1.1 billion, six-year capital investment program. Approximately 60% (or $650 million) of that investment will be spent on the company's Carol Lake (Labrador West) mine, concentrator and pellet plant operations, with the remainder being spent on reactivating the pellet plant at Sept-Îles in Quebec. The bulk of the investment will be spent on plants

and related equipment, an expansion of hydro-electric capacity, and locomotives. However, a small portion of this capital will be used to upgrade mining equipment and for expanding iron ore production.

In Ontario, new ores continued to be found at various mines, with significant developments at the Campbell and Red Lake gold mines in the Red Lake area and at the Copper Cliff North, Copper Cliff South and McCreedy East nickel-copper mines in Sudbury, where deep ore was discovered. In April 1998, Inco Limited announced a US$125 million, two-phase expansion and extension program at the Creighton nickel-copper mine in Sudbury that will extend the mine life at Creighton by two decades. Phase 1, currently under way, will develop proven reserves of 2.8 Mt grading 3.45% nickel and 2.97% copper located between the 7400 and 7660 levels. Production from this ore is scheduled to start in 2001 and continue through 2013. Phase 2 will develop 3.1 Mt of probable reserves grading 3.62% nickel and 3.25% copper that are situated between the 7660 and 8180 levels for production between 2005 and 2019. Creighton along with Copper Cliff North, Copper Cliff South and McCreedy East have become the four key and lowest-cost mines in Inco's Ontario Division. At the Red Lake mine, an aggressive ore development and production expansion program went into high gear after a new High Grade Zone was discovered in early 1998. The mine is now scheduled to re-open in late 2000. The capital cost for redeveloping and re-opening the mine is estimated at US$56 million. Gold production is projected to be 240 000 oz/y at a cash cost of US$88/oz, which would make this the lowest-cost gold mine in Canada when it re-opens next year. The development of new ore zones continued at the Campbell mine where the Reid shaft was commissioned in mid-1998. Overall, the four-year US$51 million expansion and mine life extension program initiated in 1995 is scheduled for completion in 1999. The mine is expected to maintain the current 300 000-oz/y gold production level in 1999 at a cash cost of US$140/oz, maintaining Campbell's status as one of the lowest-cost gold producers in Canada.

IMPACT

In 1998, the number of mine closings in Canada was nearly double the number of mine openings. Although there was a substantial net gain in ore production capacity, there was a significant net loss in direct mining jobs. New mines and re-openings brought on stream some 58 900 t/d of ore production capacity and created 1646 mining jobs. However, about 35 300 t/d of ore production capacity and 2430 jobs were lost from mine closures and production suspensions. This amounted to a net gain of 23 600 t/d of ore production capacity and a net loss of some 780 jobs. Most of the net gain in ore production capacity came from two large new mines: the 40 000-t/d Kemess South gold-copper mine in British Columbia and the 9000-t/d Panda (Ekati) diamond mine in the Northwest Territories. Although the two mines contributed 60% of new mining jobs in Canada in 1998, they were insufficient to offset the aggregate effect of job losses from 17 mine closings. There were substantial additional job losses that resulted from production cutbacks by mines in 1998, especially gold, base-metal and coal mines. Total job losses due to production cutbacks during the year amounted to more than 700, compared with 500 in 1997. Although a significant number of jobs were created each year since 1994 from mine expansions and extensions, fewer than 100 jobs were estimated to have been created this way in 1998 to help offset the negative impact of job reductions through production cutbacks. Many mines have managed to maintain the employment of a number of mine workers whose jobs would otherwise have been eliminated through production cutbacks had an expansion or extension not taken place at these mines.

Mine openings in 1998 are expected to contribute significantly to Canada's total minerals and metals production. At full capacity, production from new and re-opened mines in 1998 is expected to be some 11.9 t (384 000 oz) of gold, 32 700 t of copper, 1500 t of zinc and 3 Mct of diamonds annually (Table 3). While most of the new gold and copper production (65% and 83%, respectively) comes from the Kemess South mine in British Columbia, all of the new coal production comes from the Costello mine in Saskatchewan and all of the diamond production comes from the Ekati (Panda) mine in the Northwest Territories. During the year, Canada also began producing primary barite for drilling by the oil industry. As well, asbestos production was revived in British Columbia. All of this new production is essential to offset production losses from mine closings and to maintain Canada's mineral production from existing mines. Most of the new mines are expected to produce into the next century.

Table 4 shows that new and re-opened mines in 1998 have also added over 140 t, or 5 million oz, of gold reserves; 14.5 t, or 467 000 oz, of silver reserves; 490 000 t of copper reserves; and 12 600 t of zinc reserves to Canada's total reserves of these metals. In addition, some 14.5 Mct of diamond reserves, 80 Mt of coal reserves and 100 000 t of barite reserves were added. All new metal and coal reserves are essential for replenishing reserves that have been depleted due to production and for sustaining Canada's minerals and metals production capability. The start of diamond production from the Panda pit in 1998 not only boosted Canada to the rank of diamond producer, but the significant amounts of gem-quality diamond reserves at the Panda pipe and at the overall Ekati diamond

complex, together with those at other Canadian diamond developments, will enable Canada to become one of the world's top diamond producers in the foreseeable future.

New Developments Expected to Become Mines in 1999

The data presented above indicate that the overall decline in metal prices that began in 1997 persisted in 1998 and has resulted in fewer mine openings than closings and more postponements of mine developments in 1998. At the beginning of 1999, preliminary estimates indicate that some 10 mines could come on stream during the year. Among the most promising new mines are the Buchans (barite), Midatlantic (limestone/dolomite) and Shabogamo (silica) mines in Newfoundland; the Bell Allard (zinc-copper) and East Amphi (gold) mines in Quebec; the Kapuskasing (phosphate) mine in Ontario; and the McClean Lake and McArthur River (uranium) mines in Saskatchewan.

Two mining operations at which production was suspended re-opened in the early part of 1999. These are the Myra Falls zinc-copper mine (which also has significant by-production of lead, silver and gold) in British Columbia and the Con gold mine in the Northwest Territories (the Myra Falls mine re-opened in early April and the Con mine re-opened in May 1999). In addition, several previous mine expansion and extension projects, including ones that were initiated in 1998, are expected to continue in 1999, with others likely to be announced during the year. These expansions and extensions, together with new mine developments, are central to sustaining mining and production in Canada. In the face of weak commodity prices and without having to resort to layoffs, mine expansion is one of a few options by which production costs can be lowered and productivity increased at an existing mine. This is especially beneficial for mines that have significant new ore discoveries, for example, the Doyon and LaRonde mines in Quebec and the Campbell, Red Lake, Copper Cliff North, Copper Cliff South and Creighton mines in Ontario.

Outlook

During 1998, mine openings and mine developments were postponed in Canada as the down-cycle in metal prices affected all of the major metals. Coal mining was also affected by depressed coal prices. Gold mines and gold development projects were the hardest hit, followed by copper, nickel and coal projects. Gold sales by central banks, oversupply, and the lingering Asian crisis continued to put downward pressure on gold, base-metal and coal prices and made project financing difficult for most companies. Companies responded by closing high-cost mines, cutting back on production to keep marginal operations afloat (this included extended summer shut-downs), and postponing mine openings and developments. Some 10 mines are likely to open and 18 are likely to close in 1999 with a considerable net loss in mining employment. The capital investment for mines to open in 1999 is estimated at \$800 million, considerably lower than the \$1.5 billion for 1997 and \$1.4 billion for 1998.

As gold prices seem likely to remain weak for the foreseeable future, few gold mines are expected to open in 1999.

Several important new mines are expected to come on stream in 1999. These include the Bell Allard zinc-copper mine in Quebec and the McClean Lake and McArthur River uranium mines in Saskatchewan. While both the McClean Lake and McArthur River uranium deposits are world-class, McArthur River is the world's largest and richest uranium deposit. With mineable reserves of at least 73 000 tU in ore grading 16% uranium and geological reserves of 87 000 tU in material averaging 10% uranium, production is planned at an annual rate of 6920 tU (18 million lb U_3O_8) by the year 2000.

Because major Western economies remain strong and there are signs of Asian recovery in the first half of 1999, demand for metals could begin some modest recovery in 2000. This demand, to some extent, is expected to be augmented by a reduction in metal inventories that should result from mine closures around the world since 1997. But demand for gold is likely to remain weak due to oversupply from mine production, which has resulted in part from a stronger-than-expected resistance by companies to mine closures, continued gold sales by central banks, and possible gold sales by the International Monetary Fund (IMF). Unless gold sales by central banks and the IMF can be properly regulated, and with demand from Asia rising significantly because of expected economic recovery, weak gold prices will likely continue in the foreseeable future to help offset the impact of these gold sales. Overall, the number of Canadian mine openings in 2000 and 2001 is forecast to be about 14 and 18, respectively, with capital investments in those years of some \$1 billion and \$800 million respectively. The \$720 million Magnola magnesium project in Quebec's Eastern Townships, which is scheduled to begin production in 2000, contributes to the higher capital investment in 2000 than in 2001. With fewer mines expected to close during those two years (about 12 in 2000 and 14 in 2001), the Canadian mining industry could expect net gains in production capacity and new jobs. The net gains from mine openings should contribute significantly to tax revenues and spin-off social and economic benefits for Canadians. As many important

new mines, including several large and world-class industrial mineral, coal, uranium and diamond mines, are under development and are expected to come on stream between 1999 and 2002, Canadian mining will recover from the current downturn and become more diversified.

Note: Information in this review was current as of May 15, 1999.

TABLE 1. MINE OPENINGS AND CLOSINGS IN CANADA, 1998

Province/ Territory	New Mines			Mines Re-Opened			Mines Suspended			Mines Closed		
	Precious Metals	Base Metals	Other Minerals	Precious Metals	Base Metals	Other Minerals	Precious Metals	Base Metals	Other Minerals	Precious Metals	Base Metals	Other Minerals
Newfoundland	–	–	1	–	–	–	–	1	–	–	–	–
New Brunswick	–	–	–	–	–	–	–	2	–	–	–	–
Quebec	–	–	–	–	–	–	–	–	1	–	–	–
Ontario	–	–	–	1	–	–	–	–	–	–	3	1
Manitoba	–	–	–	1	–	–	–	–	–	–	1	–
Saskatchewan	–	1	–	–	–	1	–	–	–	1	–	–
British Columbia	1	–	1	1	–	–	–	1	–	1	–	–
Yukon	–	–	–	–	–	–	–	2	–	1	–	–
Northwest Territories	–	–	1	–	–	–	2	–	–	–	–	–
Canada, total by commodity group	1	1	3	3	–	1	2	6	1	3	4	1
Total Canada		5			4			9			8	

Source: Natural Resources Canada, based on company reports.
– Nil.

TABLE 2. MINE OPENINGS, RE-OPENINGS, EXPANSIONS, EXTENSIONS, SUSPENSIONS AND CLOSURES IN CANADA IN 1998

Mining Project	Location	Province/ Territory	Ore Capacity	Employment during Mine Life1	Date of Opening, Re-Opening, Expansion, Extension, Suspension or Closure	Mine or Plant Type	Main Commodities	Companies	Remarks
			(tonnes/day)						
NEW OPERATIONS									
Precious Metals									
Kemess	N-central B.C.	B.C.	40 000	350	May 13	O/P	Gold, copper	Royal Oak Mines Inc.	The Kemess South gold-copper mine began production in May 1998. The mine was developed at a capital cost of $470 million, which was 9.3% higher than first estimated due to unforeseen construction-related issues. Planned production was 250 000 oz of gold and 60 million lb of copper per year. Although commercial production was achieved in the summer months, the mine has yet to reach full production. At the start of production, ore reserves stood at slightly over 200 Mt grading 0.629 g/t gold and 0.224% copper. Due to low gold and copper prices and financial difficulties, the owner, Royal Oak Mines Inc., sought bankruptcy protection in February 1999 and was put into receivership in early May. Currently, the mine is operated by the receiver PricewaterhouseCooper Ltd. until it can be sold to help satisfy the company's $665 million debt. Royal Oak's Timmins Division gold mines (the Pamour and Nighthawk mines) and two advanced development projects (the Matachewan and Duport projects) in Ontario, and the Giant gold mine in Yellowknife, N.W.T., are also for sale.
Base Metals									
Konuto Lake (Denare Beach)	Creighton	Sask.	600e	150	September	U/G	Copper, zinc	Hudson Bay Mining and Smelting Co., Limited	The project was advanced to the development stage prior to 1998. The mine began production in September 1998. It reached commercial production at the beginning of April 1999. Ore is milled at the company's concentrator at Flin Flon, Manitoba. For 1999, production is estimated at 8500 t of copper. As of January 1, 1999, ore reserves stood at 1.05 Mt grading 4% copper, 1.2% zinc, 8.3 g/t silver and 1.8 g/t gold. Developed at a capital cost of $23.4 million, the mine has an estimated mine life of about five years. The mine essentially replaces the company's Photo Lake copper-zinc mine near Snow Lake, Manitoba, which ceased production in September 1998. The mine also absorbed the work force at Photo Lake.

Other Minerals									
Collier Point	Trinity Bay	Nfld.	75●	11	Summer	O/P	Barite	Phoenix Minerals Corp. and Newfoundland Barite Ltd.	Mining at Collier Point began in the early summer of 1998. The mine produced 7400 t of barite in 1998. Production is expected to reach the designed capacity of 10 000 t/y of barite. This small but locally important operation is the first barite producer in Newfoundland to supply the oil drilling industry in recent years.
Cassiar tailings	Cassiar	B.C.	150●	50●	July	Tailings and later U/G	Asbestos	Minroc Mines Inc.	Minroc Mines Inc., formerly Mineral Resources Corporation, became the new owner of the property by acquiring Cassiar Chrysotile Inc. in May 1998. Production began in July 1998 at the Cassiar mine site from the reprocessing of asbestos tailings. Planned production in 1998 was 4000 t of chrysotile fibre for export to Japan, India and other Asian markets. As of July 1, 1998, asbestos tailings reserves at Cassiar stood at 17 Mt grading 4.5% asbestos, sufficient for 13 years of production. In addition, there are 6 Mt of stockpiled ore grading 5-6% asbestos. The company plans to reactivate the nearby McDame underground mine for production. As well, tests are under way to produce magnesium from asbestos tailings on site.
Panda (Ekati mine)	Lac de Gras	N.W.T.	9 000	650	October 14	U/G	Diamonds	BHP Diamonds Inc., Charles Fipke and Stewart Blusson	The Panda open-pit mine, Canada's first diamond mine, opened for production on October 14, 1998. Panda is one of five diamondiferous kimberlite pipes of the Ekati mining complex which, now generally referred to as the Ekati mine, consisted of four other pipes: Koala, Misery, Sable and Fox. The five pipes were approved by the federal government to be developed as five mines for production between 1998 and 2008, sharing one common mill at the Panda site. Initial estimates put the total reserves and resources for all pipes at 133 Mt. About 78 Mt of ore are scheduled to be mined over the 17-year initial life of the project. Given that additional pipes have been discovered and several of them are higher-grade, the project can reasonably be expected to have a life of 25 years or more. The overall capital cost to production is estimated at US$700 million. The current ore production rate at Panda is 9000 t/d. This rate is expected to increase to 18 000 t/d by the year 2008 when all five pipes are in production. At full production, the Panda pit is expected to produce 3 Mct of diamonds per year.

TABLE 2 (cont'd)

Mining Project	Location	Province/ Territory	Ore Capacity (tonnes/day)	Employment during Mine Life[1]	Date of Opening, Re-Opening, Expansion, Extension, Suspension or Closure	Mine or Plant Type	Main Commodities	Companies	Remarks
RE-OPENINGS									
Precious Metals									
Madsen	Red Lake	Ont.	500	80e	July 23	U/G	Gold	Claude Resources Inc.	The Madsen gold mine first opened in 1938. Operations were suspended in 1976 due to insufficient workings being developed to sustain production. Madsen Gold Corp. re-opened the mine in June 1997, but the mine was soon put on care and maintenance due to the low gold price and production difficulties that arose from insufficient development. In April 1998, Claude Resources Inc. acquired Madsen Gold Corp. and assumed mine operations. However, the original mining plan, which focused on the past workings of the main Austin zone, had to be redesigned to meet production needs. Complementary feedstock from the newly developed McVeigh zone is expected to boost ore production to the 725-t/d level from the 500-t/d level by the first quarter of 1999. Currently, ore reserves are estimated at about 1.1 Mt grading 9.26 g/t gold.
Bissett (formerly San Antonio)	170 km NE of Winnipeg	Man.	900	150	June	U/G	Gold	Harmony Gold (Canada) Inc.	The Bissett gold mine was previously redeveloped between 1995 and 1997 and was re-opened in July 1997 by Rea Gold Corporation. Production was suspended when Rea Gold declared bankruptcy in December 1997. Harmony Gold (Canada) Inc., a South African-controlled company, acquired the mine in the spring of 1998 and it was re-opened in June of the same year. About $10 million was invested in additional development, equipment and infrastructure to bring the mine back into production. At the start of 1998, ore reserves were estimated at about 2.1 Mt grading 8.2 g/t gold. Production is planned at 60 000 troy oz of gold per year. The mine life is estimated at 10 years.
Blackdome	Clinton	B.C.	180	80e	October	U/G	Gold	Claimstaker Resources Ltd., MCM Minerals Ltd. and Petro Plus Inc.	The mine was first brought on stream in the spring of 1986 by Blackdome Mining Corporation. Originally outlined ore reserves were depleted in December 1990. Claimstaker Resources Ltd. acquired the property in 1995. A positive feasibility study was completed in Septermber 1997 and the mine was re-opened for production in October 1998. Gold production is expected to be 12 000 oz annually. At the start of 1998, ore reserves stood at 200 464 t grading 15.3 g/t gold.
Other Minerals									
Costello	Estevan	Sask.	7 500e	125e	January	Strip	Coal	Saskatchewan Power Corporation and Luscar Ltd.	Production at the Costello mine re-started in January 1998 and was gradually increasing throughout the year. The mine was redeveloped to replace the nearby Utility mine where coal reserves are expected to be depleted by early 1999. Coal (lignite A) production from the mine is expected to be about 2.3 Mt/y. At the start of 1998, coal reserves stood at an estimated 80 Mt of lignite. The mine is now a part of the Boundary-Dam East mining complex, which combines the Costello and Shand mine operations.

EXPANSIONS AND EXTENSIONS

Precious Metals

Copper Rand 5000	Chibougamau	Que.	3 000	2 000*	1997-2001	U/G	Gold, copper	MSV Resources Inc.	Due to weak metal prices, production at the Copper Rand mine was suspended in November 1997. However, since April 1997, more than substantial amounts of ore between the 4000 and 5000 levels were outlined. At the beginning of 1999, ore reserves stood at 2.19 Mt grading 1.71% copper, 3.737 g/t gold and 7.61 g/t silver. Indicated resources of 2.57 Mt of similar grades also exist. Currently, the project is under development for production in 2001. The capital cost to production is estimated at $40 million. Rehabilitation work on shaft No. 4 began in October 1998.
Doyon	Cadillac	Que.	3 500	453	1994-2001	U/G	Gold	Cambior inc.	In early 1998, Cambior inc. purchased the remaining 50% interest in the Doyon mine from Barrick Gold Corporation. As a result, Cambior now owns 100% of the mine and has become the its operator. During 1998, the company's Mouska mine was integrated with the Doyon mine and definition drilling has extended existing ore reserves by 12%. At the beginning of 1999, ore reserves at the Doyon Division mines stood at 11.1 Mt grading 7.4 g/t gold or 2.6 million oz of gold in situ. Capital expenditures in 1998 totaled $26 million. The mine produced 239 600 oz of gold in 1998 at a direct mining cost (cash cost equivalent) of US$226/oz. The plan for 1999 is to increase production to 260 000 oz at a direct mining cost of US$200/oz, with a further 43 700 oz of gold from the Mouska mine. Capital expenditures for 1999 by the Doyon Division are targeted at $25 million, including the sinking of an internal shaft at Mouska and further underground exploration and development.
Joe Mann	Chibougamau	Que.	2 700	257	1996-1999	U/G	Gold, copper	Campbell Resources Inc.	A $13.5 million, 18-month capital program, which began in 1997, to deepen the main shaft by 300 m and to develop the West zone was completed in 1998. As well, underground drilling was initiated to delineate a newly discovered mineralized area 300-400 m east of the existing mine shaft. Underground drilling confirmed the zones in the area are open to the east and downdip. The average grades drilled range from 2.7 to 27.6 g/t gold. In addition, surface drilling confirmed the mine's Main zone at a depth of between 900 and 1050 m, with two zones appearing to be the extension of a new zone discovered between the 2500 and 2575 levels. Development on this level is expected to reach the updip extension of those zones by the end of the second quarter of 1999. The mine produced 70 100 troy oz of gold in 1998, down slightly from the previous year, but cash costs fell to US$257/oz from US$264/oz.

TABLE 2 (cont'd)

Mining Project	Location	Province/ Territory	Ore Capacity	Employment during Mine Life[1]	Date of Opening, Re-Opening, Expansion, Extension, Suspension or Closure	Mine or Plant Type	Main Commodities	Companies	Remarks
			(tonnes/day)						
EXPANSIONS AND EXTENSIONS (cont'd)									
Precious Metals (cont'd)									
Kiena	Val-d'Or	Que.	1 700	195	1997-1999	U/G	Gold	McWatters Mining Inc.	Since acquiring the Kiena and Sigma mines from Placer Dome Inc. in September 1997, McWatters Mining Inc. has embarked on a US$23 million program to reduce costs, develop newly discovered deep ore zones, and extend the mine life by 10 years. In 1998, McWatters produced a total of 169 255 troy oz of gold from the Kiena and Sigma (Sigma-Lamaque) mines and from preproduction at the East Amphi mine at a cash operating cost of US$255/oz and a total production cost of US$281/oz. In the recent fourth quarter at Kiena, gold production totaled 22 203 oz at a cash operating cost of US$211/oz, whereas the Sigma-Lamaque complex produced 20 152 oz at US$330/oz (see Sigma below).
LaRonde	Val-d'Or	Que.	1 800	296	1997-2000	U/G	Gold, zinc, copper, silver	Agnico-Eagle Mines Limited	Exploration drilling continued to extend mineralization at the LaRonde mine at depth in 1998. The newly dicovered 20N zone had been traced over a vertical distance of more than 1600 m and the zone remains open at depth and to the west. As a result, reserves and resources above the 10th level now exceed 14 Mt grading 1.37 g/t gold, 79.5 g/t silver, 0.17% copper and 6.55% zinc; reserves below the 10th level total 10.6 Mt grading 4.45 g/t gold, 87.4 g/t silver, 0.58% copper and 4.76% zinc. As well, a new zinc circuit was brought on stream in September 1998 to process zinc ore at the mine. At full production, this circuit is expected to produce 52 000 t of zinc annually. Since 1997, the mine has embarked on a $256 million expansion program, which includes mill expansion and shaft sinking. By year-end 1998, about $193 million remained to be spent over the next three and a half years. The project currently under way is expected to increase gold production to 220 000 oz/y by 2001 at an average production cost of US$125/oz after zinc, copper and silver credits. In 1998, gold production at LaRonde was 150 000 oz at a cash operating cost of about US$213/oz. Agnico-Eagle is contemplating a second expansion program that could increase gold production to more than 280 000 oz/y at an average cost of US$100/oz.

Sigma	Val-d'Or	Que.	1 200	300*	1997-1999	O/P and U/G	Gold	McWatters Mining Inc.	The mine was acquired by McWatters Mining Inc., along with the Kiena mine, from Placer Dome Inc. in September 1997. The Sigma mine complex, now referred to as the Sigma-Lamaque complex, consists of the Sigma No. 1 underground mine and the Sigma No. 2 and No. 3 open-pit mines. Since the acquisition, the company has embarked on a US$23 million cost-cutting, mine-life extension program at both Sigma and Kiena (see Kiena above). By the end of the first quarter of 1999, about $9.7 million had already been spent on underground exploration and development and on modern mining equipment at Sigma-Lamaque. These efforts have boosted underground reserves and resources at the complex by 30%, and a construction program has increased the daily ore production capacity from the underground operations to 1200 t from 700 t. During 1998, $8.3 million was spent. New resources added include the Sigma 2000 discovery. In February 1999, mining was suspended at the underground operation for an anticipated five-month period. About 179 of the complex's 250 employees were laid off. During the shut-down, the company will undertake a feasibility study to prove the viability of an operation at Sigma-Lamaque that would coordinate both open-pit and undergound mining to produce 100 000 oz of gold annually at a cash cost of US$200/oz over 10 years.
Campbell	Balmertown	Ont.	1 585	380	1997-1999	U/G	Gold	Placer Dome Inc.	In 1998, deep ore development and shaft extension continued at the Campbell mine. Final completion of a four-year US$51 million depth development program that began in 1995 is expected to be completed in mid-1999. The new Reid shaft will reach a depth of 1900 m below surface to access ore below the current workings; to provide a second, more efficient underground access; and to allow for exploration drilling to greater depths. A significant part of the mine property remains to be explored and a number of existing zones are likely to be expanded. Production at the mine decreased by 14% to 68 379 oz in the first quarter of 1999 compared with 1998 due to a lower head grade; the cash production cost was marginally lower at US$132/oz compared with US$135/oz in the same period a year earlier. However, cash and total costs are expected to rise modestly due to higher mill costs and with the mid-year commissioning of the new shaft (the Reid shaft). The mine is expected to sustain its current rate of production of at least 300 000 troy oz of gold per year well into the next decade at the 1999 cash production cost of about US$140/oz.

TABLE 2 (cont'd)

Mining Project	Location	Province/ Territory	Ore Capacity	Employment during Mine Life[1]	Date of Opening, Re-Opening, Expansion, Extension, Suspension or Closure	Mine or Plant Type	Main Commodities	Companies	Remarks
			(tonnes/day)						
EXPANSIONS AND EXTENSIONS (cont'd)									
Precious Metals (cont'd)									
Lac-des-Îles	Thunder Bay	Ont.	2 650	145*	1998-1999	O/P	Palladium, platinum group metals, nickel, copper, gold	North American Palladium Ltd.	Encouraged by positive results of a scoping study, the company is considering an expansion of the open-pit operation. The producer has budgeted $1.5 million for further diamond drilling and metallurgical work to confirm mineable reserves and resources. Currently, production came from the Roby zone which, at the end of 1998, hosted ore reserves of 7.8 Mt grading a combined platinum group metals (PGM) grade of 4.217 g/t. The mine is Canada's only primary producer of palladium.
Red Lake	Balmertown	Ont.	550	250*	1998-2000	U/G	Gold	Goldcorp Inc.	Significant exploration success since 1995 has led to the continuous extension of ore reserves at the Red Lake gold mine. Although the mine's production has been suspended since June 1996 by a strike, underground exploration continues to discover and delineate high-grade ore. The current focus is on the recently discovered High Grade Zone. At the end of 1998, gold reserves in the zone were increased by 47% to 1.39 million oz with an average cut grade of 46.63 g/t (1.36 oz/st) and an average uncut grade of 90.17 g/t (2.63 oz/st). A feasibility study completed in the fall of 1998 indicated that the mine can be redeveloped for production in the last quarter of 2000 at a capital cost of US$56.2 million ($4.4 million in 1998, $51.1 million in 1999 and $0.7 million in 2000; $15 million of the total is for a new milling and concentrating plant). Gold production is expected to be 240 000 oz/y, quadrupling the level prior to the strike, at a cash cost of US$88/oz and a total operating cost of US$137/oz over a 6.5-year mine life. In addition, 35 000 oz/y is expected to be recovered upon installation of a refractory treatment process. The mining rate will likely be maintained at the 550-t/d level. In the meantime, exploration continues to expand ore reserves in the "sulphide-style" and the "high grade-style" mineralized zones laterally and at depth.

Seabee	La Ronge	Sask.	600	150	1998-1999	U/G	Gold	Claude Resources Inc.	In 1998, production from the mine reached a record 60 200 troy oz of gold at a cash operating cost of US$168/oz, a 22% cost reduction from 1997. At the start of 1999, ore reserves stood at 559 800 t grading 8.97 g/t gold. Mining during the year was primarily focused on the 2C zone between the 110- and the 340-m levels, as well as mining on the 2H zone. Considerable development occurred on the Currie Rose property immediately west of the mine between the 110- and 290-m levels. Claude Resources Inc. now owns 100% of the Currie Rose property subject to a 30% net profits interest payable to Currie Rose Resources Inc., after pay-out of development and exploration expenditures incurred by Claude Resources Inc. to bring the property into production. The Currie Rose project was brought on stream in early 1999 with a mining rate of no less than 30 000 t/y of ore. The ore mined will be treated at Seabee. In March 1999, the combined Seabee and Currie Rose reserves stood at 560 000 t averaging 8.29 g/t gold, with an additional 349 000 t in the possible category. During 1998, Claude Resources also successfully acquired Madsen Gold Corp. and assumed development and production at the Madsen gold mine near Red Lake in northern Ontario.
Base Metals									
Creighton	Sudbury	Ont.	3 500*	525	1998-2001 (Phase 1) 2001-2005 (Phase 2)	U/G	Nickel, copper, cobalt, precious metals	Inco Limited	In April 1998, Inco Limited announced a two-phase, US$125 million project to develop a 6-Mt high-grade, low-cost nickel-copper deposit at the Creighton mine over the next two decades. The first phase, currently under way, will develop proven reserves of 2.8 Mt grading 3.45% nickel and 2.97% copper located between the 7400 and 7660 levels. Production from this ore is expected to begin in 2001 and continue through 2013. The second phase involves the development of 3.1 Mt of probable reserves grading 3.62% nickel and 3.25% copper. This ore, situated between the 7660 and 8180 levels, is expected to be mined between 2005 and 2019. In contrast, the average grade of the Ontario Division mines is 1.3% nickel and 1.1% copper. When in full production, this Creighton Deep project is expected to produce 10 900 t of nickel, 9500 t of copper and 28 000 oz of platinum group metals annually.
McCreedy East	Sudbury	Ont.	1 800	180	1996-1999	U/G	Nickel, copper, cobalt, precious metals	Inco Limited	A $194 million capital program to fully develop the mine and to expand capacity since its opening in 1996 continued in 1998. By the end of 1998, mine production had exceeded the year's target of 1800 t/d ore throughput. It is estimated that, by the end of 1999 or early 2000, major development work at the mine would be completed and daily ore capacity could exceed 2700 t. Inco has designated McCreedy East as one of four key mines in its Ontario Division. The other three, Creighton, Copper Cliff North and Copper Cliff South, are all in the Sudbury area. When in full production, McCreedy East could produce some 14 500 t/y (32 million lb) of nickel, and will be one of the lowest-cost nickel-copper producers in the company's Ontario Division.

TABLE 2 (cont'd)

Mining Project	Location	Province/ Territory	Ore Capacity	Employment during Mine Life[1]	Date of Opening, Re-Opening, Expansion, Extension, Suspension or Closure	Mine or Plant Type	Main Commodities	Companies	Remarks
			(tonnes/day)						
SUSPENSIONS									
Precious Metals									
Con	Yellowknife	N.W.T.	810	340	May 14	U/G	Gold	Miramar Mining Corporation	Production was suspended on May 14, 1998, due to a labour dispute. The strike ended in April 1999 and production resumed immediately. A new operating plan calls for an annualized rate of gold production of approximately 100 000 troy oz/y. Gold production will come from a combination of free mill and refractory ores and will be supplemented by gold recovered from the reprocessing of roaster sludges. The company believes production can be maintained at this level for approximately five years without any significant capital expenditures or capital development. At the end of April 1999, free-milling ore reserves stood at 1 Mt grading 12 g/t (0.35 oz/st) gold. In addition, the mine has a block of mixed free-mill and refractory ores of 0.45 Mt grading 10 628 g/t (0.31 oz/st) gold. The mine is expected to maintain ore production at a rate of about 800 t/d (540 t/d for free-mill ore and 270 t/d for refractory ore), a reduction from its design capacity of 1270 t/d.
Lupin	Contwoyto	Nunavut	2 085	500	January 7	U/G	Gold	Echo Bay Mines Ltd.	Production was suspended in January 1998 due to low gold prices and high operating costs. A preliminary re-engineering study completed in the third quarter of 1998 indicated that under a new cost structure, Lupin can accomplish a life-of-mine average cash operating cost of US$245-$255/oz in current dollars. Cost reductions could be made by mining 18% fewer tonnes, using a smaller work force, and constructing a winze to gain access to ore below the 1130-m level without affecting the head grade or ore reserves. However, annual production will likely fall to 150 000 troy oz of gold. Lupin contains the Centre, West and McPherson zones, all of which are open at depth and have the potential to extend mine life. However, the decision to re-open the mine will depend on the gold price. During 1998, limited drilling was carried out to evaluate the McPherson zone, which was discovered in 1997. However, the company later decided that further work on the zone would best be funded by cash flows from production when the mine re-opens, possibly in 2000.
Base Metals									
Beaver Brook	Glenwood	Nfld.	600	80	February	U/G	Antimony	Roycefield Resources Ltd.	Production at the mine was suspended in February 1998 due to low antimony prices. The Beaver Brook antimony deposit was discovered in 1989 and was brought on stream in November 1997 at an estimated capital investment of $14.6 million. Roycefield had estimated that at full production the mine could supply approximately 5% of the world's antimony market for 20 years.

Caribou and Restigouche	Bathurst	N.B.	3 000	280	August 2	U/G and O/P	Zinc, lead, silver, gold	Breakwater Resources Ltd.	Production at the two mines was suspended in August 1998 due to low metal prices. The company has since conducted technical and economic studies that included further pilot plant testing to determine the possibility of re-opening the mines. The results indicate that, in addition to higher metal prices, the flotation capacity in the mill will have to be expanded and the primary grind increased. A re-opening feasibility study is currently under way by company personnel. The mines had been plagued by lower-than-expected mill recoveries since its re-opening in August 1997. Breakwater Resources Ltd. acquired the Caribou mine in 1990 from East West Caribou Mining Limited and suspended the operations in October of that year due to poor metallurgical recovery and low metal prices.
Grum and Vangorda	Fargo	Yukon	12 000	386	January 16	O/P	Zinc, lead, silver, gold	Anvil Range Mining Corporation, Cominco Ltd. and Hyundai Corporation	Production was suspended in January 1998 due to low metal prices. Subsequently, an attempt by Anvil Range Mining Corporation to restructure the debt payment plan with debt holders, including partner Cominco Ltd., failed and Anvil Range is now in receivership. The Vangorda pit was mined out in early 1998 with a small amount of ore stockpiled on site. In addition, about six years of ore reserves remain at the Grum mine. Operations at the two mines were last suspended in December 1996. Production resumed in October 1997 after Cominco Ltd. acquired a 28% interest in Anvil Range in February 1997.
Myra Falls	Campbell River	B.C.	4 000	360	Mid-December	U/G	Zinc, copper	Boliden Limited	Production at Myra Falls was suspended in mid-December 1998 due to ground problems within the Battle and Gap zones of the mine. Poor ground conditions had led to the dilution of ore and lower head grades. About 270 of the 360 workers were kept on site during the suspension to carry out stope-and-access route rehabilitation and development. The work was successful and the mine re-opened on April 1, 1999. The capital cost for this work is estimated at $9.8 million. However, some rehabilitation work remains to be done; therefore, Boliden Limited is predicting the mine will be running at 75-85% of capacity in the second quarter of 1999, with full production expected in the third quarter. At full production, zinc output from the mine will be 110 000 t of zinc annually. Boliden acquired the Myra Falls operations in January 1998 through a $520 million acquisition of two-thirds controlling interest in Westmin Resources Limited of Vancouver. By winning control of Westmin, Boliden also picked up the company's Gibraltar copper-molybdenum mine in B.C., which closed in February 1999 because of low copper prices. Currently, Taseko Mines Limited is acquiring the mine and intends to resume production.

TABLE 2 (cont'd)

Mining Project	Location	Province/ Territory	Ore Capacity	Employment during Mine Life[1]	Date of Opening, Re-Opening, Expansion, Extension, Suspension or Closure	Mine or Plant Type	Main Commodities	Companies	Remarks
			(tonnes/day)						
Other Minerals									
St. Onge	Lac-Saint-Jean	Que.	550	75	June 1	O/P	Wollastonite	Orleans Resources Ltd.	Production at the mine was suspended on June 1, 1998, due to the low wollastonite price and the need to modify production objectives. There was sufficient inventory to meet short-term sales demand. About 20 workers were kept on site to provide sales support and to prepare for the resumption of production. The mine began production in November 1997 from one of the largest wollastonite deposits in the world and was Canada's first wollastonite mine. Upon re-opening the mine in the summer of 2000, the mine is expected to be able to supply the market with three types of high-acicularity concentrates of different grades. Wollastonite concentrate production will likely be maintained at the 50 000-t/y level. The capital cost for re-opening the mine is estimated at $8 million.
CLOSURES									
Precious Metals									
Contact Lake	La Ronge	Sask.	700	50	June	U/G	Gold	Cameco Corporation and Uranerz Exploration and Mining Limited	The mine was closed in June 1998 due to ore depletion. Mining ceased in April 1998 and milling was completed in June. Production in 1998 was 29 000 troy oz of gold at a cash cost of approximately US$170/oz. Decommissioning of the site will continue in 1999. The first commercial production at the mine began in January 1995.
QR	Quesnel	B.C.	1 000	90	April	O/P and U/G	Gold	Kinross Gold Corporation	Due to declining gold prices, the company decided to close the mine. Underground production ceased in February 1998 and milling of stockpiled ore was completed in April. The open-pit operations were completed in 1997. Initial site stabilization work was completed in 1998. The majority of the closure reclamation work is scheduled for completion in 1999. The mine first began production in May 1995.
Klondike	Dawson City	B.C.	1 500*	24	January	Placer	Gold	Teck Corporation	The mine was closed in January 1998 due to the depletion of placer gold ore reserves. Although small, scattered pockets of pay gravel remain, some of which could be mined by local operators, and the mine is under Temporary Closure Permit, it is not expected to re-open. The mine first began production in April 1980.

Base Metals									
Shebandowan	Thunder Bay	Ont.	2 540	300	Second Quarter	U/G	Nickel, copper, cobalt, platinum group metals, gold, silver	Inco Limited	The mine was closed in the second quarter of 1998 due to low metal prices and high costs. The move is part of Inco's focus on profitable mine production, including the closing or phasing out of higher-cost mines. About 300 contract employees at the mine were affected. The mine first began production in 1972. Production was suspended in May 1992 due to poor market conditions. Production resumed in October 1995. Annual output from the mine was 5400 t of nickel.
Whistle	Copper Cliff	Ont.	2 000	55	Summer	U/G	Nickel, copper, cobalt, platinum group metals, gold, silver	Inco Limited	The mine was closed in 1998 for the same reason as for the Shebandowan mine above. Some 55 workers were affected. The mine produced from 1988 to 1991; it re-opened in 1994. Its annual production was about 4100 t of nickel.
Winston Lake	Schreiber	Ont.	900	162	December 4	U/G	Zinc, copper	Inmet Mining Corporation	The mine was closed in December 1998 due to low metal prices. A subsequent study that included additional underground drilling and further evaluation of the development at the nearby Pick Lake deposit failed to prove the operation economic for production resumption in the foreseeable future. The company has since decided to permanently close the mine, which first began production in April 1988.
Photo Lake	Snow Lake	Man.	500	43	September	U/G	Copper, zinc, gold, silver	Hudson Bay Mining and Smelting Co., Limited	The mine closed in September 1998 due to ore depletion. Workers at the mine were relocated to the Konuto Lake mine, the company's new mine at Creighton, Saskatchewan. The Photo Lake mine first began production in mid-1995.
Other Minerals									
George MacLeod	Wawa	Ont.	3 150•	225	May 16	U/G	Iron	Algoma Steel Inc.	Due to high costs and a resulting lack of competitiveness, the company decided to close the mine in 1998. The company was paying $8 million-$12 million more for iron ore produced from the mine than from its Tilden mine in Michigan. All of the approximately 200 workers at the mine have been offered jobs at the company's mill at Sault Ste. Marie, Ontario, where the company is headquartered. Algoma Steel will now rely completely on the Tilden mine for iron ore supply. It holds a 45% interest in the Tilden mine and Stelco Inc. owns another 15%.

Source: Natural Resources Canada, based on company reports and communications with companies.
• Estimated.
O/P open-pit; U/G underground; st Short ton.
1 Employment refers to workers on the company's payroll and to contract workers at an operation, or at an operation prior to its closure.
Note: A mine that closed and re-opened in the same year is shown under both categories.

TABLE 3. NEW PRODUCTION FROM MINE OPENINGS IN CANADA IN 1998

Mining Project	Main Commodities	Estimated Annual Production[1]					
		Gold	Gold	Copper	Zinc	Diamonds	Other Minerals
		(g)	(oz)	(t)	(t)	(ct)	
NEW OPERATIONS							
Precious Metals							
Kemess	Gold, copper	7 775 870	250 000	27 200	–	–	–
Base Metals							
Konuto Lake (Denare Beach)	Copper	–	–	5 500	1 500	–	–
Other Minerals							
Collier Point	Barite	–	–	–	–		10 000 t barite
Cassiar tailings	Asbestos	–	–	–	–	–	50 000 t asbestos (by 2000)
Panda (Ekati mine)	Diamonds	–	–	–	–	3 000 000	
RE-OPENINGS							
Precious Metals							
Madsen	Gold	1 555 170	50 000	–	–	–	–
Bissett (formerly San Antonio)	Gold	1 866 200	60 000	–	–	–	–
Blackdome	Gold	746 480	24 000	–	–	–	–
Other Minerals							
Costello (now part of Boundary-Dam East)	Coal						2.3 Mt thermal coal
Planned total		11 943 720	384 000	32 700	1 500	3 000 000	

Source: Natural Resources Canada, based on company reports and communications with companies.
– Nil.
[1] Panda was the first of five diamondiferous kimberlite pipes of the Ekati diamond mining complex to come on stream in Canada, to be followed by Koala and Misery in 2002, Sable in 2007 and Fox in 2008. Production will increase as the remaining four pipes are brought on stream and will double its current level by 2008.

TABLE 4. NEW ORE RESERVES FROM MINE OPENINGS IN CANADA IN 1998

Mining Project	Main Commodities	Proven-Probable Ore Reserves[1] Tonnage	Grade	In-Situ Metal Reserves Gold	Gold	Silver	Silver	Copper	Zinc	Other Minerals
		(tonnes)		(g)	(oz)	(g)	(oz)	(t)	(t)	
NEW OPERATIONS										
Precious Metals										
Kemess	Gold, copper	200 440 000	0.224% copper 0.629 g/t gold	126 076 760	4 053 460	–	–	448 980	–	–
Base Metals										
Konuto Lake (Denare Beach)	Copper	1 050 000	4% copper 1.2% zinc 1.84 g/t gold 8.345 g/t silver	1 932 000	62 110	8 762 250	281 700	42 000	12 600	
Other Minerals										
Collier Point	Barite	100 000•	Barite	–	–	–	–	–	–	100 000 t barite
Cassiar tailings	Asbestos	14 000 000	3.5% asbestos (recoverable fibre)	–	–	–	–	–	–	490 000 t asbestos
Panda (Ekati mine)	Diamonds	12 6000 000	1.09 c/t diamonds - OP	–	–	–	–	–	–	13 734 000 ct diamonds
		800 000	0.97 c/t diamonds - U/G	–	–	–	–	–	–	776 000 ct diamonds
RE-OPENINGS										
Precious Metals										
Madsen	Gold	1 100 000	9.26 g/t gold	10 186 000	327 480	–	–	–	–	–
Bissett (formerly San Antonio)	Gold	600 000•			600 000	–	–	–	–	–
Blackdome	Gold	155 930	14.8 g/t gold	2 307 760	74 200	5 769 400	185 490	–	–	–
			37 g/t silver	–	–	–	–	–	–	–
Other Minerals										
Costello (now part of Boundary-Dam East)	Coal	80 000 000	Lignite A	–	–	–	–	–	–	80 000 000 t lignite A
Total				140 502 520	5 117 250	14 531 650	467 190	490 980	12 600	

Source: Natural Resources Canada, based on company reports and communications with companies.
– Nil; • Estimated.
[1] Panda was the first of five diamondiferous kimberlite pipes of the Ekati mining complex to come on stream in Canada, to be followed by Koala and Misery in 2002, Sable in 2007 and Fox in 2008. At the end of 1998, total mineable reserves and additional resources for the five pipes stood at 133 Mt. Total capital cost for developing the five pipes will be US$700 million and the overall employment will be 830 direct jobs.

International Scene

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INTRODUCTION

The year 1998 will go down as a difficult one for Canada's minerals and metals industry. Asia's economic troubles, which had started in mid-1997, spread to Japan, the world's second largest economy. A ripple effect spread to South America and exacerbated the financial crisis in Russia. In mid-year, Canada's economy slowed and the dollar dipped sharply lower against the U.S. dollar and some of the European currencies. The economies of the United States and Western Europe were the only ones to escape relatively unscathed.

The Asian economic troubles had serious repercussions for the world's mining industry, with metal prices dropping substantially, some to levels not seen for many years and others to historic lows. Canada, a major mineral exporter, suffered due to the uncertain outlook for these commodities; Australia, another major exporter, suffered similarly.

The concept of sustainable development of natural resources, and specifically minerals and metals, came to the forefront in 1998. Both governments and industry increasingly recognized the need to address the three components – economic, environmental and social – as part of their policies and business plans. Some of the significant events were:

- the "Workshop on The Sustainable Development of Non-Renewable Resources Towards the 21st Century," organized by the United Nations Revolving Fund for Natural Resources Exploration;
- "Sustainable Development of Land and Mineral Resources," a conference organized by the Economic and Social Commission for Asia and the Pacific;
- the "Pan-American Workshop on the Safe Use of Minerals and Metals," organized by Canada and Peru, in partnership with Chile and Argentina, under the Action Plan of the 1997 annual Mines Ministers of the Americas Conference (CAMMA);
- the "Environmental Cooperation Workshop for Sustainable Development of Mining Activities," organized by the Expert Group on Mineral and Energy Exploration and Development (GEMEED) under the auspices of the Asia-Pacific Economic Cooperation (APEC);
- the launch of the "Mineral Resources Forum," an Internet site developed as an initiative of the United Nations Conference on Trade and Development (UNCTAD); and
- an international workshop, "Sustainable Development Criteria and Indicators for Minerals and Metals: Moving from Words to Action," hosted by the Minerals and Metals Sector of Natural Resources Canada (NRCan).

Some specific Canadian-sponsored activities related to sustainable development issues include: the International Development Research Centre's Mining Policy Research Initiative "Mining and Sustainable Development in the Americas"; the Canada Centre for Mineral and Energy Technology's (CANMET) projects to foster capacity building in Latin America, funded by the Canadian International Development Agency (CIDA); and an Industry Panel on the theme "Towards Sustainable Development of Minerals and Metals" held as part of the Annual Meeting of the APEC GEMEED in Ottawa.

As in previous years, environmental and health-based government regulations affecting the use of and trade in minerals and metals and their products continued to be of concern to the world's minerals and metals sector. These regulations have the potential to affect market access for these commodities and products, not only in Europe but also in countries that are traditional manufacturers of such products, such as Japan. In international fora, Canada continued to promote its *Safe Use Principle*, which is a risk-based approach to managing environmental and health concerns associated with minerals and metals production, use, recycling and disposal.

Mining's image suffered with a cyanide spill at the Kumtor mine in the Kyrgyz Republic and a tailings spill at the Los Frailes mine in Spain. The Kumtor cyanide spill caused widespread panic and negative media coverage. However, an international scientific commission concluded that although the spill was serious, only a small number of people were briefly at risk and the effects were exaggerated. At Los Frailes, the Doñana National Park appeared to have escaped serious damage, and the clean-up of tailings was substantially complete by year-end.

The International Council on Metals and the Environment and the United Nations Environment Programme (UNEP) held a "Workshop on Risk Assessment and Contingency Planning in the Management of Mine Tailings" in Buenos Aires. The Mining Association of Canada, in response to some recent high-profile tailings spills, developed and published its *Guide to the Management of Tailings Facilities*.

Through CANMET, the Government of Canada provided assistance to Canadian mining companies and foreign governments in their response to mine-related environmental incidents (e.g., in Spain and the Kyrgyz Republic).

This review covers major international issues of importance to the Canadian minerals and metals sector, including multilateral, regional and bilateral developments during 1998.

MULTILATERAL DEVELOPMENTS

World Trade Organization (WTO)

The WTO held its second ministerial summit in May 1998, which included anniversary celebrations of the coming into being of the General Agreement on Tariffs and Trade (GATT) 50 years earlier. Ministers agreed to postpone until 1999 a formal decision on whether, and when, to begin the next round of multilateral negotiations. Various proposals for the next round were put forward with the European Union (EU) pushing for a comprehensive "Millenium Round" and the United States favouring a more selective, sectoral approach. The developing countries indicated their preference for a round that focuses on deepening tariff commitments made during the Uruguay Round.

In a key development, the Ministerial Declaration issued at the end of the summit called on the WTO to "increase its efforts toward the objective of sustainable development" (SD), which falls within the responsibility of the Committee on Trade and Environment (CTE). The EU and the United States have put forward proposals to upgrade the CTE's mandate for approval at the 1999 ministerial summit. The United States, which will host the next ministerial summit in 1999, would like to improve the WTO's "green" credentials, and will seek to make this issue a priority at the summit. To support this policy direction, the United States will co-sponsor, with the EU, a meeting of trade and environment ministers of WTO members to provide long-term direction to the WTO's activities in pursuit of SD.

OECD-Sponsored Multilateral Agreement on Investment (MAI)

International negotiations among Organization for Economic Co-operation and Development (OECD) countries to reach agreement on a multilateral agreement on investment (MAI) were officially suspended in October 1998 when France announced its intention to withdraw from the process. Progress in the discussions had been severely hampered by increasing pressure from a number of segments of civil society that had been expressing concerns about the potential implications of an investment agreement on the ability of countries to regulate in the spheres of environment, occupational health and safety, and culture.

While a number of countries held out hope that the process could be transferred to the broader multilateral arena of the WTO, it became clear that any effort to conduct negotiations within that forum would attract similar opposition.

The OECD and Chemicals Issues

In January 1998, Canada, the United States, Japan, the United Kingdom and industry hosted an OECD workshop in London to explore ways to advance the use of socio-economic analysis in risk management decision making for chemicals, including minerals and metals. Participants acknowledged the benefits of using socio-economic analysis and developed a series of recommendations to improve data quality and transparency in the development and interpretation of socio-economic analyses.

In February 1998, the OECD Risk Management Advisory Group meeting and the OECD joint Meeting of the Chemicals Group and Management Committee endorsed the findings and recommendations resulting from the "Workshop on the Integration of Socio-Economic Analysis in Risk Management Decision Making" and the OECD "Workshop on the Effective Collection and Recycling of Nickel-Cadmium (Ni-Cd) Batteries," which was held in 1997. The latter workshop supported an earlier OECD finding that recycling is the preferred risk management option for Ni-Cd batteries, and identified a number of opportunities to enhance recycling, including international harmonization of battery marking systems to improve collection and sorting.

Mexico expressed an interest in starting a domestic recycling program and hosted a workshop in December 1998 to advance recommendations from the 1997 OECD workshop.

Basel Convention on the Transboundary Movements of Hazardous Wastes and Their Disposal

The intent of the Basel Convention, which came into force in May 1992 and has been ratified by more than 100 countries, was to restrict the transboundary movement of hazardous wastes in order to protect those countries, particularly developing countries, that might not have the capacity or technology to handle them in an environmentally sound manner. The Convention defines recycling as a "disposal" activity, and recyclable materials as "wastes." Canada and some other governments have expressed concerns that the Convention does not adequately distinguish between recyclable materials destined for recovery operations and hazardous wastes destined for final disposal.

The fourth Conference of the Parties (CoP) was held in February 1998. Delegations agreed to amend the Basel Convention to add two new annexes. The first annex (Annex VIII) comprises a list of hazardous wastes that will become subject to the movement "ban" agreed to at CoP3, if and when it enters into force. The second annex (Annex IX) comprises a list of materials that are generally considered not hazardous and that will be excluded from the scope of the regulatory framework established by the Convention. Most recyclable metals are included on the second, non-hazardous annex list. The delegations further agreed to extend the mandate of the Technical Working Group to formally establish a "review mechanism" to revise and update the new annexes as may be required.

Delegations also reviewed requests submitted by Monaco, Israel and Slovenia to accede to Annex VII. These requests stem from the desire of these countries to be able to continue to receive hazardous recyclable materials from OECD member countries. However, the delegations at CoP4 rejected all accession requests, preferring to defer them until the movement ban has entered into force. The delegations further refused to agree to the development of technical criteria that could assist countries in a self-evaluation of their hazardous waste management capacities. The development of technical criteria was perceived as a step towards allowing countries to join Annex VII and was rejected by most member countries.

Meanwhile, the Parties also continued negotiations to reach agreement on a protocol that would govern liability and compensation issues arising from incidents involving the transboundary movement of hazardous wastes covered by the Convention. The legal and technical working group constituted to address this issue met in June and October in an effort to finalize the protocol, but did not succeed. Key outstanding issues include: defining commencement and termination of liability; defining the liable person; minimum insurance levels; limits on liability; and the creation of a compensation fund to ensure victim recovery for damages suffered.

Law of the Sea Convention: Seabed Mining Code

In June, the G-10 (Japan, the United States, the United Kingdom, France, the Netherlands, Russia, Germany, Canada, Belgium and Italy) met in The Hague to exchange views on the current draft Regulations on Prospecting and Exploration for Polymetallic Nodules in the Area. The objective of the meeting was, to the extent possible, to develop common positions on key provisions within the draft regulations in preparation for the session of the Council of the International Seabed Authority in August 1998. The group reviewed the draft regulations and, in particular, focussed on those provisions dealing with environmental protection, preservation of confidentiality, and the powers of the International Seabed Authority.

In August, the International Seabed Authority held its annual meeting in Kingston, Jamaica, the seat of the Authority. The Council met on a daily basis over the course of two weeks in an effort to conduct a thorough review of the draft Mining Code. As had been expected, most of the discussion focussed on those provisions dealing with confidentiality and with environmental protection from the impacts of seabed exploration.

Heavy Metals Protocol under the Convention on Long Range Transboundary Air Pollution (LRTAP)

Negotiations in the United Nations Economic Commission for Europe (UN/ECE) to develop a protocol to govern emissions of heavy metals quickly became the focus of an attempt by some countries to broaden the scope to include product controls and bans. Eventually, it was agreed that the negotiations would focus on reducing airborne emissions of lead, cadmium and mercury as a first step. The final protocol does, however, include criteria and a process by which other metals, such as nickel, copper and zinc, could be added later. Canada successfully introduced its percentage reduction in emissions approach into the protocol as an acceptable obligation. The protocol was signed by Canada in June 1998 and ratified in December 1998.

Rotterdam Convention on the Prior Informed Consent Procedure (PIC) for Certain Hazardous Chemicals and Pesticides in International Trade

Intergovernmental negotiations – sponsored by the UNEP and the United Nations Food and Agriculture Organization (FAO) – to turn two existing voluntary arrangements (the *London Guidelines* and the FAO *International Code of Conduct*) covering a handful of pesticides and chemicals into a legally binding convention that would establish export controls on a range of substances and products concluded with an agreement in March 1998. Once the Convention comes into force, exporters located in signatory governments would have to receive, from the importing country, formal consent in advance of any controlled substance receiving an export permit. Crocidolite (blue) asbestos, mercury and arsenic-based pesticides, which are covered by the voluntary arrangements, will be included in the legally binding instrument. Despite efforts by the EU to have consumer chemicals included in the definition of "chemical," it was agreed to exclude them. The Convention's coverage is limited to banned or severely restricted industrial chemicals and severely hazardous pesticide formulations.

For a chemical to be considered for inclusion on the PIC "list," the Secretariat must first receive notifications by Parties to the Convention from at least two PIC regions indicating that the they have banned or severely restricted that chemical. A Chemical Review Committee then examines the notifications and makes a recommendation, which takes into account whether the chemical has been subjected to a risk evaluation, to the CoP on whether the chemical should be included on the PIC list. The CoP – on the basis of consensus – decides whether to accept the recommendation, thus effectively giving a veto to all Parties.

The Convention also provides that where a country has banned or severely restricted a chemical that it is exporting, it must provide prior notification to the importing Party upon the first shipment and on an annual basis following the first shipment.

Canada signed the Convention at the Rotterdam diplomatic conference in September 1998 and indicated its intention to ratify it quickly.

Persistent Organic Pollutants (POPs)

POPs are predominantly man-made, toxic chemicals that, to varying degrees, resist photolytic, biological and chemical degradation. They are characterized by low water/high lipid solubility, which leads to their accumulation in fatty tissues, and are semi-volatile, being able to travel long distances in air. POPs include PCBs, dioxins and furans. Canada has played, or is playing, an active role in the following POPs initiatives:

UN/ECE

The LRTAP Convention, negotiated in the context of the UN/ECE (which includes Canada and the United States for historical reasons), has a number of well-known protocols covering emissions of sulphur dioxide (SO_2), nitrogen oxides (NO_x) and volatile organic compounds (VOCs). Since 1989, Canada has played a lead role in seeking to secure agreement on a POPs protocol under the LRTAP Convention. The protocol on POPs, for which negotiations concluded in March 1998, was signed by Canada at the June 1998 UN/ECE Environment Ministers' meeting in Denmark and ratified in December 1998.

UNEP

At its 19th Session in 1997, the UNEP Governing Council agreed to develop an international, legally binding instrument to protect human health and the environment through measures that would reduce/eliminate the emissions and discharges of the 12 identified POPs (DDT, aldrin, dieldrin, endrin, chlordane, heptachlor, hexachlorobenzene, mirex, toxaphene, PCBs, dioxins and furans). The first international negotiating conference was held in early July 1998 and a second in January 1999. The intention is to conclude negotiations and adopt and sign an international, legally binding instrument for international action by the year 2000.

Intergovernmental Forum on Chemical Safety (IFCS)

In 1997, a number of countries (notably Sweden, the Netherlands and Germany) proposed that the IFCS become involved in activities on chemicals of international concern other than POPs. Sweden offered to organize a workshop to identify health and environmental problems caused by chemicals that pose significant health and environmental risks, and to undertake an overview of national, regional and international work to identify hazardous chemicals and to control their risks. This workshop did not take place, but Sweden renewed its workshop proposal at the meeting of the Forum Standing Committee in Yokohama in late 1998.

During the IFCS Forum II meeting in 1997, the United States proposed that the IFCS should add consideration of endocrine disrupting substances (EDS) to its agenda. As a result, the Forum Standing Committee requested that the Inter-Organization Programme for the Sound Management of Chemicals (IOMC) compile definitions appropriate to endocrine disruption, promote coordinated research, delineate

testing methods, and adopt and maintain an inventory of research activities. The IOMC reported on its progress at the IFCS meeting in Yokohama.

United Nations Economic and Social Council (ECOSOC)

ECOSOC concluded discussion on the reform of the "four friends," the regional commission and the functional commissions. The main outcome of the discussions concerned the "four friends" where two committees – the Committee on Natural Resources and the Committee on New Renewable Sources of Energy – were amalgamated into a single Committee on Energy and Natural Resources for Development. This new committee will address energy and freshwater issues, but not minerals issues.

United Nations Commission on Sustainable Development (CSD)

The 1992 UN Conference on Environment and Development called for the creation of the CSD to: ensure effective follow-up of *Agenda 21*; enhance international cooperation and rationalize intergovernmental decision-making capacity; and examine progress in *Agenda 21* implementation at the local, national, regional and international levels. Discussions at the 1997 UN Special Session to review implementation of *Agenda 21* outlined a five-year work program for the CSD.

In 1998, CSD 6 dealt with freshwater management and the Intergovernmental Forum on Forests. In future years, CSD 7 (1999) will include the sectoral theme of Oceans and Seas and the cross-sectoral theme of Changing Consumption and Production Patterns. CSD 8 (2000) is expected to have greater implications for the mining, minerals and metals industry as it will be examining Integrated Planning and Management of Land Resources, Financial Resources, Trade and Investment and Economic Growth, Agriculture, and the reporting of the Intergovernmental Framework on Forests. In addition, the 8th session will showcase a Day of Indigenous Peoples.

United Nations Conference on Trade and Development (UNCTAD) Mineral Resources Forum Web Site

The newly created "Mineral Resources Forum" is an initiative of UNCTAD with financial assistance from the Government of the Netherlands. The UNEP Industry and Environment Centre in Paris is a principal partner in the Forum, which can be found on the Internet at http://www.natural-resources.org/.

The Forum is a framework for international cooperation on the theme of minerals, metals and sustainable development, bringing together governmental and intergovernmental actors, resource companies and other concerned organizations and persons from civil society. The Forum is structured to encourage interaction among a diverse set of users and to promote an integrated, inter-disciplinary approach to mineral issues and policies, and will cover a broad range of technical and socio-economic issues that arise during the "life cycle" of mineral resources. The three subject areas – Economics, Environment and Society – embrace a whole range of mineral matters that are of worldwide interest or that have general applicability. In addition, there is a General Forum devoted to major cross-cutting issues requiring integrated, inter-disciplinary treatment.

Bilateral/Regional and Other Developments

Americas

Third Mines Ministers of the Americas Conference (CAMMA)

The third annual CAMMA was hosted by Argentina in Buenos Aires. Attended by nineteen countries, four more than in 1997 (Colombia, the Dominican Republic, Guatemala and Haiti), it demonstrated the increasing value of this high-level meeting as an effective consultative forum and agency for cooperation among countries of the hemisphere with substantial interests in the minerals and metals sector. CAMMA is noteworthy because it is the only high-level forum that addresses mining and minerals issues in the Americas.

Canadian concepts and approaches to the sustainable development of minerals and metals, including the *Safe Use Principle*, were again acknowledged. The "Pan-American Workshop on the Safe Use of Minerals and Metals" was reflected in the Declaration and its three annexes: a) the conclusions of the government officials meeting held in conjunction with the "Pan-American Workshop on the Safe Use of Minerals and Metals"; b) the conclusions from the three panel discussions at the Preparatory Conference in Lima in July, which include, for the first time, a definition of the safe use of minerals and metals; and c) a list of 17 projects for the 1999 Plan of Action.

A Coordinating Committee with provision for working groups of technical experts from interested countries was created to establish appropriate networks to implement activities in the action plans. This permanent committee will comprise the current Executive Secretariat, the next host country, and a representative from each of North America, Central America, the Caribbean, MERCOSUR countries, and South American countries other than MERCOSUR. For

1998/99, the member countries are Argentina, Brazil, Canada, Cuba, Nicaragua, Peru and Venezuela.

Canada has received financial assistance from CIDA to work in partnership with the Secretariat of CAMMA (1998-2002) to assist in implementing the annual action plan endorsed by ministers.

Pan-American Workshop on the Safe Use of Minerals and Metals

The "Pan-American Workshop on the Safe Use of Minerals and Metals" was held in Lima, Peru, in July 1998. More than 100 people from 14 countries and international organizations participated in this workshop, which was co-sponsored by Canada (with financial assistance from CIDA) and Peru, in partnership with Chile and Argentina. This workshop presented the market, environmental and social context for the theme and then presented the theoretical background for the key approaches of: risk versus hazard; risk assessment and risk management; life-cycle management; and the importance of environmental and social considerations. Case studies demonstrating best practices in production and processing, product use and recycling, environment, and community relations were given the second day.

At a subsequent meeting of government officials, agreement was reached on a definition of safe use, namely: "safe use can be defined as a risk-based approach for the responsible management of minerals and metals at each state of their life cycle (from production, use, recycling, re-use and return to the environment). Its objective is to maximize benefits and at the same time minimize risks, consistent with principles of sustainable development." This definition was endorsed by ministers at CAMMA in November.

Canadian Trade and Investment Mission to Latin America

The Honourable Ralph Goodale, Minister of Natural Resources Canada, led a trade and investment mission to Argentina, Chile and Peru in November 1998. He was joined by representatives of business, Ontario and the Yukon, as well as three Aboriginal representatives. In addition to heading the Canadian delegation to CAMMA in Buenos Aires, Minister Goodale conducted a series of bilateral meetings with his counterparts in each country.

Canada-Chile Memorandum of Understanding

Minister Goodale signed a Memorandum of Understanding (MOU) on Cooperation on the Sustainable Development of Metals and Minerals with his counterpart, Minister Sergio Jiménez of the Republic of Chile. The MOU will establish a framework for further cooperation in support of sustainable development and the future use of and trade in minerals and metals in bilateral, regional and multilateral fora. The MOU supports commitments made for trade liberalization and environmental cooperation under the Canada-Chile Free Trade Agreement. The MOU is broad in scope, covering exchanges of information in such areas as law and regulations, science and technology, mineral and metal policy, and the exploration and exploitation of minerals and metals through such means as workshops and the exchange of experts and specialists. Under this framework, Canada will continue to work with Chile to foster the sustainable development and promote the safe use of minerals and metals.

Canada-Argentina Letter of Intent

Minister Goodale signed a Letter of Intent (LOI) with Sr. Alieto Guadagni, Secretary of Industry, Trade and Mining, of the Argentine Ministry of Economy, Public Works and Services. For two countries committed to the sustainable development of the minerals and metals sector, this LOI strengthens an already mutually beneficial level of cooperation that exists within the sector in areas such as sustainable development, primarily through the Mines Ministers of the Americas, and the CANMET-Instituto Nacional de Technologia Industrial (INTEMIN) national environmental mining laboratory. The LOI goes further to enhance the cooperation between Canada and Argentina through an agreement to explore ways to develop and expand cooperation through such means as information exchanges, official-level discussions, and collaboration on projects of mutual interest with the intention of encouraging increased investment and expanded trade flows between Canada and Argentina in minerals and mining-related goods, services and technology.

Science and Technology Transfer Projects in Latin America

CANMET and CIDA have been working together over the last few years to promote sound environmental practices in the minerals sector of South America. CANMET was involved in technology transfer projects in Argentina, Brazil and Guyana. The focus of these projects is mainly to strengthen institutional capacity through technology transfer and training. Typically these projects include visits to Canadian mine sites and the promotion of linkages between institutions, the private sector and academia.

Canada-U.S. Bilateral Consultations on the Tulsequah Chief Mine Project

In March 1998, the United States asked Canada to refer the Tulsequah Chief mine project, located in northern British Columbia, to the Canada-U.S. International Joint Commission (IJC) for further review of key cross-border environmental concerns raised by

the United States and the State of Alaska. The project, which had gone through a joint federal-provincial environmental assessment (EA), had been approved by both levels of government earlier that month. U.S. federal and Alaskan agencies had participated in the EA process although they had not joined in the recommendation for the project to be allowed to go ahead.

Canada suggested that the United States' concerns be examined through a bilateral consultation process. The two governments – with British Columbia and Alaska participation – met three times over the course of the remainder of 1998 in an effort to bridge their differences. While some progress was made, a mutually satisfactory solution had not been achieved by the end of the year and consultations are expected to continue into 1999.

Europe and Russia

Russia

In April 1998, Minister Goodale visited Moscow. This visit allowed Canada to discuss with Russian officials government and industry concerns about the country's investment climate for minerals. Also in 1998, collaboration by Canada and Russia in the minerals and metals sector intensified with significant progress towards establishing a bilateral mining working group under the auspices of the Canada-Russia Intergovernmental Economic Commission. As the role and membership of the mining working group become better defined, this group should provide a forum to discuss investment climate issues and other matters of mutual interest.

Europe

The year 1998 saw the European Commission moving forward on several key regulatory fronts that are likely to threaten Canadian asbestos and nonferrous metals producers.

Directorate General XI (Environment) sought to advance three proposals on managing waste arising from nonferrous metal-containing products: end-of-life vehicles; end-of-life electrical and electronic equipment; and nickel-cadmium batteries and accumulators. Key metals and metal compounds being targeted for bans or substantial restrictions included lead, mercury, cadmium and hexavalent chromium. The Commission also considered whether to increase restrictions on the use of cadmium in pigments and stabilizers, but a risk assessment led to the conclusion that existing restrictions are sufficient for the moment.

The Commission also moved forward with a proposed ban on asbestos. Although the Commission had subscribed to a controlled-use approach for many years, most of the members states had instituted bans, and the Commission decided to follow suit in order to promote harmonization.

In a related move, Canada formally announced its intention to challenge a French ban on the importation and use of asbestos using the WTO's dispute resolution mechanism. Unless the parties settle the matter bilaterally, a panel report is expected to be issued sometime in late 1999.

In December 1998, Denmark formally notified the European Commission that it intended to substantially ban all uses of lead and its compounds. The notification was made pursuant to an EU requirement that member states must notify the Commission and other member states if a regulatory action may have implications for EU law or the operation of the European single market. The Commission and member states have three months to respond to the notification.

Canada-European Union Minerals and Metals Working Group

The Canada-EU Minerals and Metals Working Group met in Brussels in June 1998. Key items on the agenda included: *The Minerals and Metals Policy of the Government of Canada* and the *Safe Use Principle*; the EU's recycling program; Canadian international initiatives to promote the sustainable development of minerals and metals; and EU regulatory initiatives focussing on restricting the use of key nonferrous metals in industrial and consumer product applications.

Asia-Pacific

Asia-Pacific Economic Cooperation (APEC)

The Expert Group on Mineral and Energy Exploration and Development (GEMEED), a subgroup of APEC's Energy Working Group, held its third Annual Meeting in Ottawa in May 1998. This meeting had as its theme the sustainable development of minerals and metals.

Significant GEMEED activities and achievements during 1998 included:

- completing the first phase of the APEC Network of Mineral and Energy Data (ANMED), its Internet-based exploration database project comprising a wide variety of member economy information, such as relevant mining and environmental legislation, and geoscientific data related to exploration;
- creating a Sub-Group on Environmental Cooperation, chaired by Japan, with its terms of reference

based on the concept of sustainable development of minerals and metals; and

- the "Environmental Cooperation Workshop for Sustainable Development of Mining Activities" (ECOW'98), held in Chile, which addressed a series of issues related to sustainable development and "clean production."

GEMEED has become increasingly focussed on the sustainable development of minerals and metals, as shown by ECOW'98 and the creation of the Sub-Group on Environmental Cooperation.

China

In 1998, NRCan co-chaired meetings of both the Canada/China Ferrous Minerals and Metals Working Group and the Canada/China Nonferrous Metals and Minerals Working Group in Beijing. The Ferrous Working Group – co-chaired with the Ministry of Metallurgical Industry – addresses issues concerning iron ore, steel and gold. The Nonferrous Working Group, which addresses base metals and aluminum, is co-chaired with the China National Nonferrous Metals Industry Corporation (CNNC). These meetings provided opportunities to exchange information on each country's mineral industry and to discuss issues related to business climate and possible areas of collaboration in science and technology. These meetings coincided with a major restructuring of government ministries and the release of the regulations for the *Mineral Resources Law*.

As part of this restructuring, the Ministry of Land and Resources, which is responsible for China's *Mineral Resources Law*, was created from the policy sector and geological survey of the former Ministry of Geology and Mineral Resources, and other state bureaus. The CNNC became the State Nonferrous Metals Industry Association (SNMIA), a policy and management body that also retains decision-making power over the CNNC's former "enterprises" during a three-year transition period. As the reforms continue, a number of specialist firms could emerge along the lines of the China Aluminium Group Corporation.

The government promulgated three series of regulations to accompany its *Mineral Resources Law*. These regulations cover exploration and registration of "claims"; registration of mining title; and transfer of mineral exploration and mining licences.

Indonesia

The Canadian Council of Professional Engineers (CCPE) signed an MOU with the Association of Indonesian Mining Professional (PERHAPI). NRCan organized, in cooperation with the Department of Foreign Affairs and International Trade and with financial support from the Canada-ASEAN Centre, the negotiation and signing of an MOU between the CCPE and PERHAPI. Through this MOU, which was signed in Jakarta in December 1998, the CCPE will assist PERHAPI to develop a framework for the accreditation and licensing of mining engineers and geoscientists in Indonesia.

Arctic

Arctic Council

The Arctic Council, which has been chaired by Canada in its two formative years, held its first high-level meeting in Iqaluit in September. The Council – an Arctic commonwealth that comprises Canada, the United States (Alaska), Greenland/Denmark, Iceland, Norway, Sweden, Finland and Russia – was formed to search for common approaches to social, environmental, health care and cultural issues in the Arctic. The Council gives "permanent participant status" to Arctic indigenous organizations: the Inuit Circumpolar Conference, the Saami Council (based in Finland), and the Russian Association of Indigenous Peoples of the North.

The results of the Council's deliberations were encompassed in the Iqaluit Declaration, which was signed by all members. Council members agreed on action plans for the next two years. Some activities relevant to the minerals and metals sector were undertaken by the Working Groups:

- The Working Group on the Protection of the Arctic Marine Environment produced a Regional Plan of Action for the Protection of the Arctic Marine Environment from Land-Based Activities, initially focussing on persistent organic pollutants and heavy metals;

- The Working Group on the Conservation of Arctic Flora and Fauna developed a strategic plan for the conservation of Arctic bio-diversity; and

- The Working Group on the Arctic Monitoring and Assessment Program released its Assessment Report entitled Arctic Pollution Issues.

Note: Information in this review was current as of May 14, 1999.

Canada's Global Mining Presence

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The Global Market for Exploration

Although it became considerably more difficult to raise risk capital during 1997 than during the previous year, exploration programs around the world for precious metals, base metals and diamonds were, in total, remarkably close to budget. In 1998, however, global exploration activity by companies of all sizes fell to an estimated \$5.0 billion (US\$3.5 billion) from \$7.0 billion (US\$5.1 billion) the previous year, or down by roughly 30%. Programs were reduced in most countries, but were postponed or abandoned entirely in some developing countries.

Global trends in worldwide mineral exploration are based largely on data for the world's larger companies,[1] defined here as those with annual exploration budgets greater than \$4 million (US\$3 million). In 1998, 182 companies planned to spend more than \$4 million on exploration, down from a record 279 in 1997. During 1998, the world's larger companies were expected to undertake programs with a combined value of \$4.0 billion (US\$2.8 billion), which represents over 80% of the global market for mineral exploration.

Larger Canadian-Based Companies

In 1996, mining companies listed on Canadian stock exchanges raised a record amount of capital.[2] As a result, the number of Canadian-based companies that planned to spend more than \$4 million on exploration around the world grew to a record 141 during 1997, up from 94 in 1996 and only 55 in 1995.

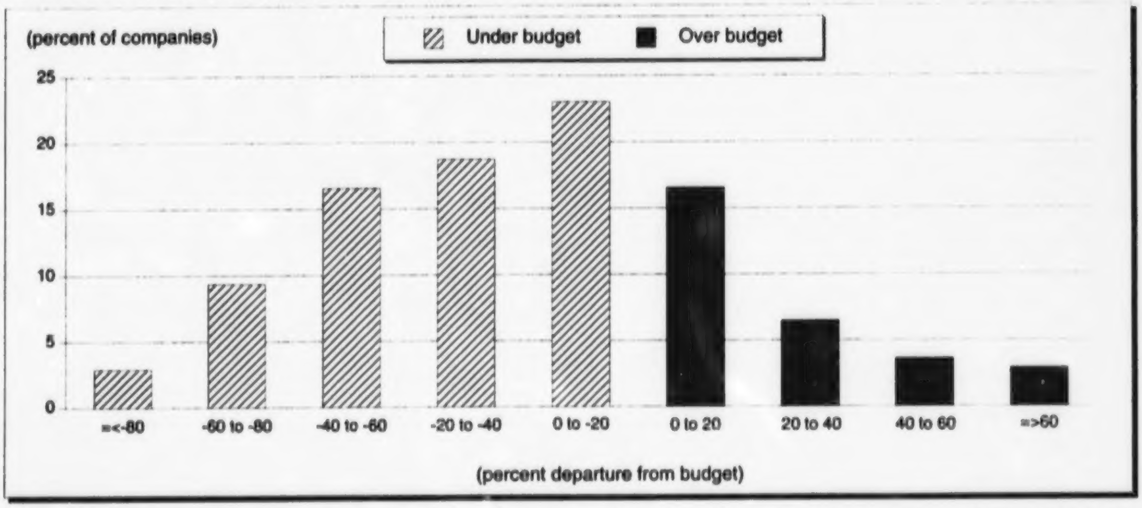
Nonetheless, during 1997, the larger Canadian-based companies underspent their exploration budgets, in aggregate, by \$160 million, or by about 8% less than they had planned (Figure 1). One third of them (94 companies) spent less than budgeted, while a little more than one quarter (37 companies) spent more than budgeted. Individual company departures from 1997 plans ranged from \$25 million under budget to \$34 million over budget. In general, companies that exceeded their program budgets during 1997 did so in response to new discoveries or other opportunities that arose during the year.

Many of the larger Canadian-based companies derive little or no substantial revenues from mineral production and, therefore, rely almost entirely on the stock market to finance their exploration programs. Because of investor uncertainty during 1997 and 1998, the number of Canadian-based companies that planned to spend more than \$4 million on exploration in 1998 decreased to 83. The total amount that these companies planned to spend on mineral exploration in both Canada and elsewhere around the world fell to \$1.3 billion in 1998 (Figure 2) from \$1.9 billion the previous year, or down by 34%. Nonetheless, during 1998, Canadian-based companies planned to undertake more than 30%, and the dominant share by far, of all the larger-company exploration programs around the world. In 1997, Canadian programs accounted for a record 35% of all worldwide mineral exploration activity.

Relatively fewer of the many companies that budgeted only somewhat more than \$4 million in 1997 were able to raise a similar amount for exploration in 1998. As a result, the average company budget for 1998 increased. In the case of the larger Canadian-based companies, the mean budget for 1998 increased to \$15.4 million and the median to \$7.1 million, up from \$13.7 million and \$6.4 million respectively the previous year.

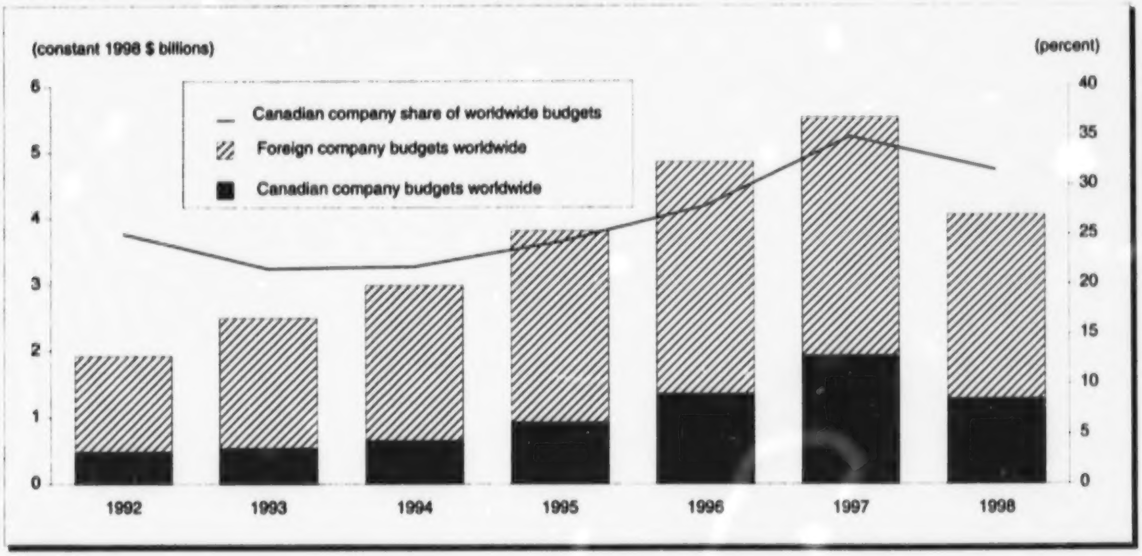
At the end of 1998, companies of all sizes listed on Canadian stock exchanges held interests in a portfolio of more than 6800 exploration or producing properties (Figure 3) located in Canada or in more than 100 countries around the world.[3] Most of this portfolio is at the exploration stage.

Figure 1
Departure of Global Exploration Expenditures from Budgets, 1997
Canadian-Based Companies with Budgets of at Least $4 Million (US$3 Million) for Precious-Metal, Base-Metal or Diamond Exploration



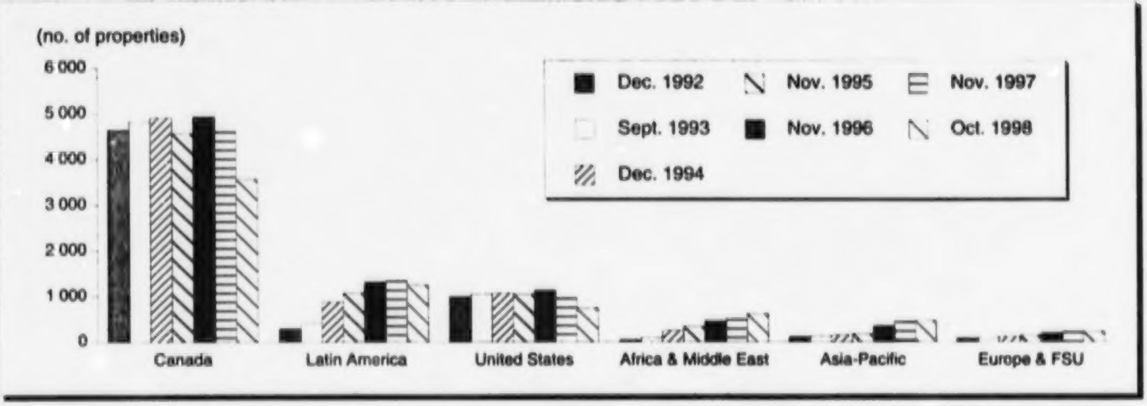
Source: Natural Resources Canada, based on *Corporate Exploration Strategies: A Worldwide Analysis*, Metals Economics Group, Halifax, Nova Scotia.
Note: During 1997, the aggregate expenditures of 139 larger Canadian-based companies were more than $160 million or 8% under budget.

Figure 2
Exploration Budgets of the World's Larger Companies, by Origin, 1992-98
Companies with Worldwide Budgets of at Least $4 Million (US$3 Million) for Precious-Metal, Base-Metal or Diamond Exploration



Source: Natural Resources Canada, based on *Corporate Exploration Strategies: A Worldwide Analysis*, Metals Economics Group, Halifax, Nova Scotia.
Notes: The worldwide exploration budgets of companies that intended to spend less than $4 million (US$3 million) annually are excluded. The worldwide exploration budgets for other commodities such as uranium or industrial minerals are also excluded.

Figure 3
Canadian Mineral Property Portfolio Worldwide, by Region, 1992-98
Companies of All Sizes Listed on Canadian Stock Exchanges



Source: Natural Resources Canada, based on *MIN-MET CANADA* database for 1992-97 and *Info-Mine* database for 1998, ROBERTSON INFO-DATA Inc., Vancouver, British Columbia, and used under licence.

Larger-Company Exploration Market in Canada

In 1998, the larger-company mineral exploration market in Canada was valued at $440 million (Figure 4). The balance of the Canadian market is held mainly by smaller companies, the activities of which are not addressed specifically here. At the end of 1998, there were more than 3500 mineral properties with recent exploration activity in this country.[4]

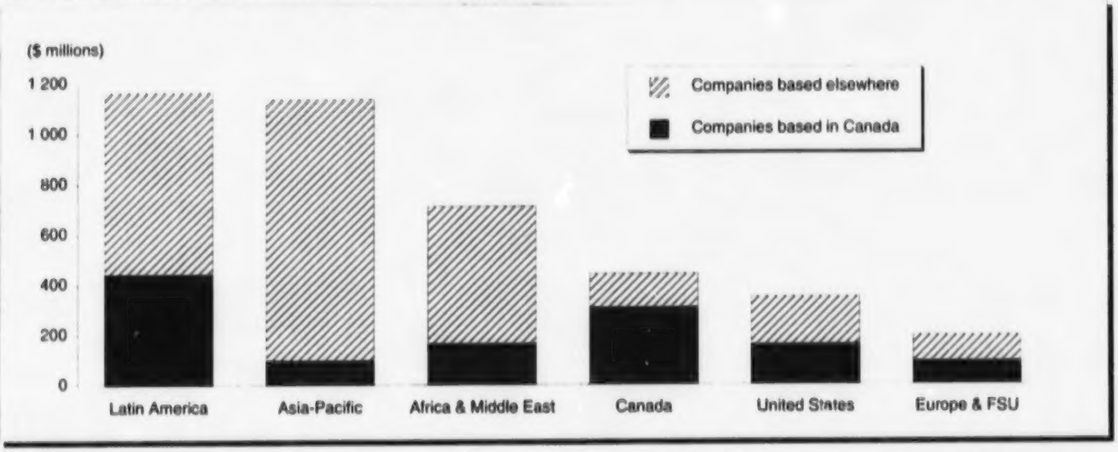
In 1998, 66 of the world's larger domestic-based or foreign-based companies allocated budgets for exploration in Canada. Their aggregate budgets for 1998 for this country were down by $155 million, or by more than 25%, compared with those for 1997. Nonetheless, almost 11% of the exploration programs of all the world's larger companies were destined for Canada (Figure 5), slightly more than in 1997. However, Canada's share of worldwide exploration activity has fallen gradually from about 18% in 1992 because of the mammoth increase in exploration activity that occurred in Latin America, Asia and Africa starting in the early 1990s.

In 1998, 49 of the larger Canadian-based companies allocated over $300 million for exploration in Canada. This represents a reduction of almost $110 million, or 26%, from the $417 million budgeted in 1997. Canadian-based companies control 70% of the larger-company market in Canada. Australia is the only other country where domestic companies control as large a share of their domestic larger-company market for mineral exploration. In 1992, Canadian-based companies controlled 80% of the larger-company market in Canada but, with increasing globalization, their share has fallen gradually as foreign-based companies have increased their investment in this country. The share of the exploration market controlled by the larger domestic firms has also declined in the United States and in Latin America. Still, Canada remains the country where Canadian companies spend the most, by far, on mineral exploration (Figure 6).

During 1998, the larger foreign-based multinationals planned to spend over $130 million on mineral exploration in Canada (Figure 5), or 30% of all exploration programs planned for this country. Compared with 1997, their budgets decreased by about one quarter. Nonetheless, their budgets are still considerably larger than the $70 million budgeted in 1992, which represented less than 20% of all exploration programs then planned for Canada.

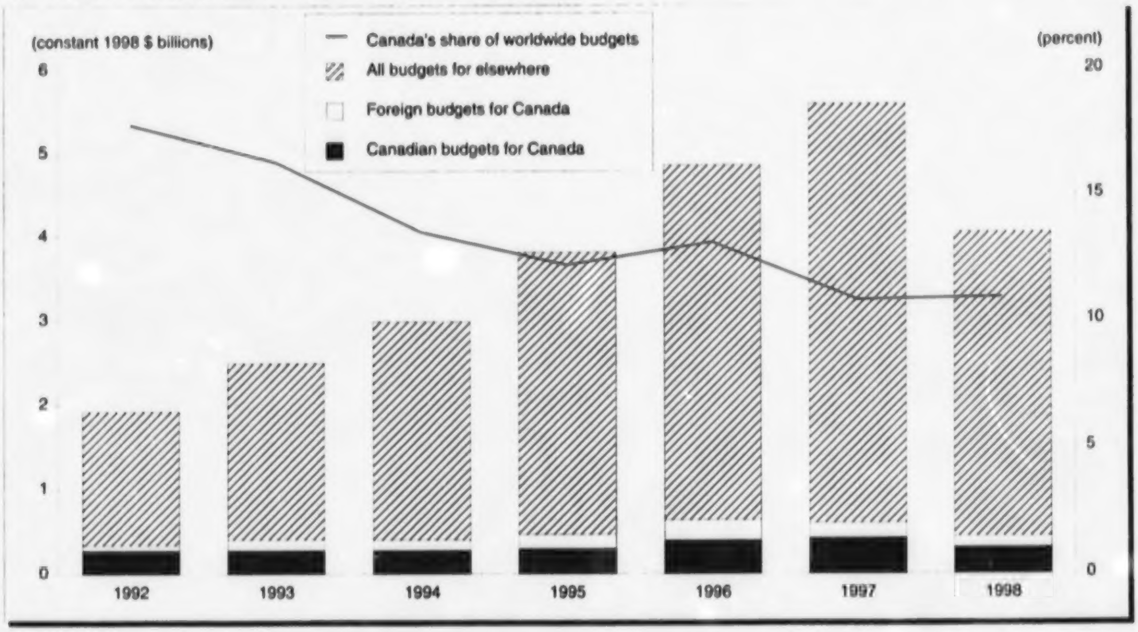
The larger foreign-based companies active in Canada include the Ashton Group, BHP Minerals Pty Ltd., QNI Ltd. and WMC Limited, all based in Australia; Battle Mountain Gold Company, Cyprus Amax Minerals Company, Echo Bay Mines Ltd., Freeport–McMoRan Copper & Gold, the Homestake Group, Newmont Gold Company, Phelps Dodge Corporation and Royal Oak Mines Inc., all based in the United States; Billiton Plc., the Minorco Group, the Outokumpu Group and the Rio Tinto Group, all based in Europe; the De Beers Group, based in South Africa; and Korea Zinc Co. Ltd.

Figure 4
Exploration Budgets of the World's Larger Companies for Selected Regions of the World, 1998
Companies with Worldwide Budgets of at Least $4 Million (US$3 Million)
for Precious-Metal, Base-Metal or Diamond Exploration



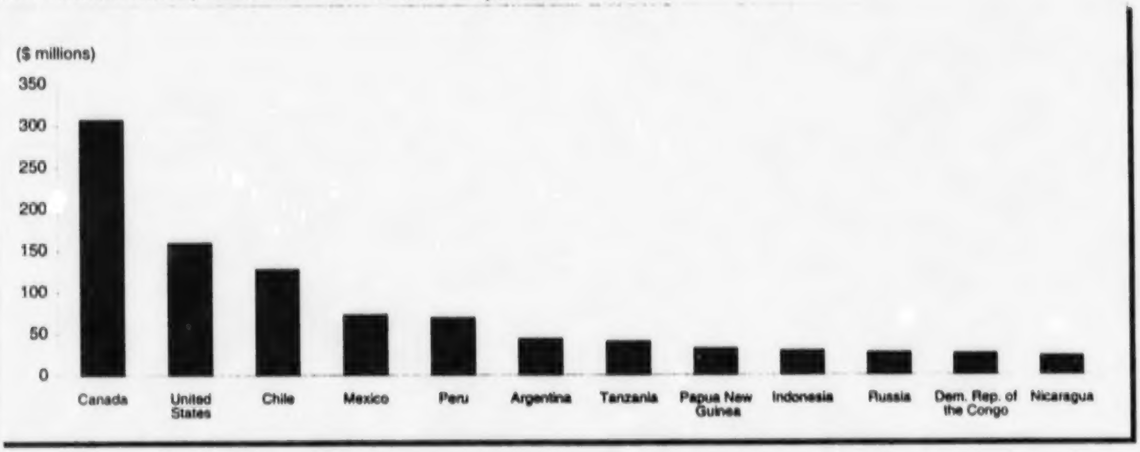
Source: Natural Resources Canada, based on *Corporate Exploration Strategies: A Worldwide Analysis*, Metals Economics Group, Halifax, Nova Scotia.
Notes: The worldwide exploration budgets of companies that intended to spend less than $4 million (US$3 million) annually are excluded. The worldwide exploration budgets for other commodities such as uranium or industrial minerals are also excluded.

Figure 5
Exploration Budgets of the World's Larger Companies for Canada and Elsewhere, 1992-98
Companies with Worldwide Budgets of at Least $4 Million (US$3 Million)
for Precious-Metal, Base-Metal or Diamond Exploration



Source: Natural Resources Canada, based on *Corporate Exploration Strategies: A Worldwide Analysis*, Metals Economics Group, Halifax, Nova Scotia.
Notes: The worldwide exploration budgets of companies that intended to spend less than $4 million (US$3 million) annually are excluded. The worldwide exploration budgets for other commodities such as uranium or industrial minerals are also excluded.

Figure 6
Exploration Budgets of the Larger Canadian-Based Companies, 1998 – Countries Accounting for 80% of Canadian Budgets
Companies with Worldwide Budgets of at Least $4 Million (US$3 Million) for Precious-Metal, Base-Metal or Diamond Exploration



Source: Natural Resources Canada, based on *Corporate Exploration Strategies: A Worldwide Analysis*, Metals Economics Group, Halifax, Nova Scotia.
Notes: The worldwide exploration budgets of companies that intended to spend less than $4 million (US$3 million) annually are excluded. The worldwide exploration budgets for other commodities such as uranium or industrial minerals are also excluded.

Larger Canadian-Based Companies Abroad

In 1998, the larger Canadian-based companies planned to spend $967 million on mineral exploration outside Canada (Figure 4). The proportion of their budgets allocated to foreign programs was almost 76% in 1998. That proportion peaked at over 78% in 1997, up from only 43% in 1992.

Canadian companies are continuing to assume increasing amounts of geological and country risk abroad. The ratio of exploration properties to the total number of exploration and producing properties held outside Canada has increased steadily since the early 1990s. In mid-1991, that ratio was 0.84 for Europe and the former Soviet Union (FSU), 0.80 for Latin America, 0.77 for Africa, and 0.67 for Asia-Pacific. By late 1998, it had increased to over 0.93 for Latin America and to 0.90 for both Africa and Asia-Pacific. In comparison, the ratio of exploration properties to the total number of properties held in Canada remained roughly constant at 0.96 between 1991 and 1997. In late 1998, it was 0.95.

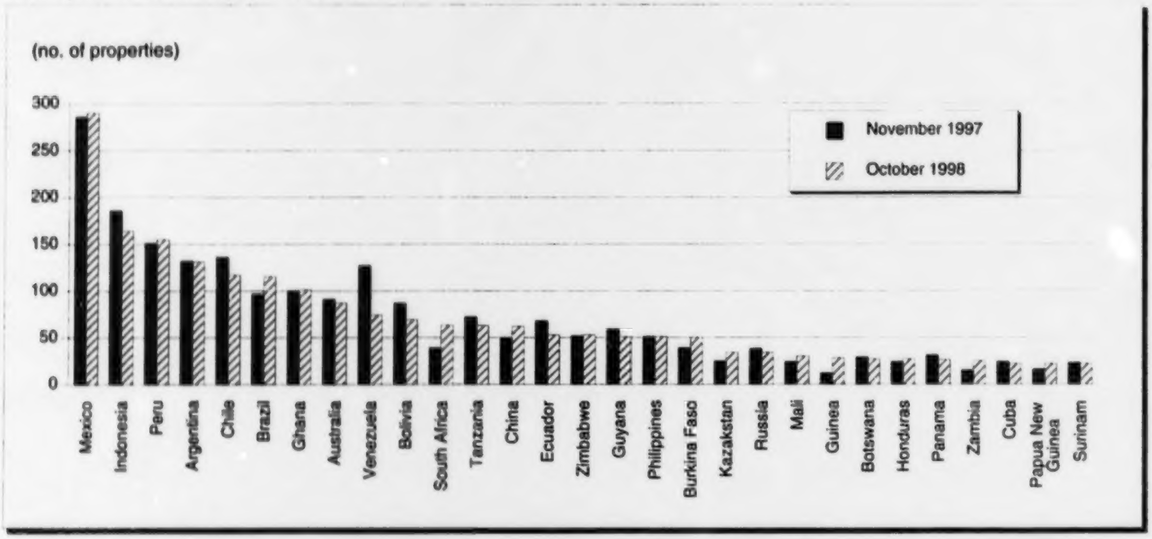
At the end of 1998, companies of all sizes listed on Canadian stock exchanges held interests in a portfolio of almost 3300 mineral properties located abroad (Figure 3). Foreign properties now represent almost half of the total mineral property portfolio held by these companies, up from about 25% in 1992.[5] Between 1992 and 1998, their holdings of foreign mineral properties grew at an average annual compound rate of almost 14%. Apart from the United States, where companies of all sizes listed on Canadian stock exchanges have a substantial mining presence, roughly two dozen other nations, spread across the globe, account for 80% of the balance of their mineral property portfolio held abroad (Figure 7).

United States

In 1998, the larger-company mineral exploration market in the United States was valued at $350 million (Figure 4), or about 9% of the $4.0 billion larger-company market worldwide. In spite of global retrenchment, over 30 of the larger Canadian-based companies planned to spend a total of about $160 million in the United States, about the same as in 1997. Because companies based in other countries considerably reduced their exploration programs for the United States during 1998, Canadian-based companies increased their share of the larger-company exploration market in that country to 46%, up from 32% in 1997. The United States ranks second in the world as the country where Canadian companies are the most active.

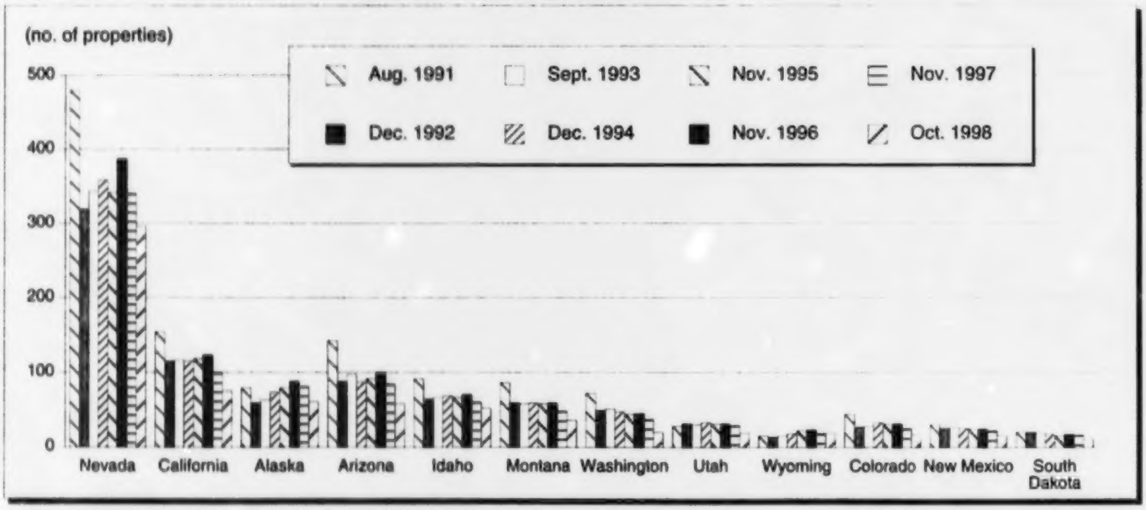
Canadian companies planned to spend almost $40 million more than U.S. companies in the United States during 1998. As a result, they became the

Figure 7
Canadian Mineral Property Portfolio Abroad, 1997 and 1998 – Countries Accounting for 80% of Canadian Holdings Located Outside the United States in 1998
Companies of all Sizes Listed on Canadian Stock Exchanges



Source: Natural Resources Canada, based on *MIN-MET CANADA* database for 1992-97 and Info-Mine database for 1998, ROBERTSON INFO-DATA Inc., Vancouver, British Columbia, and used under licence.

Figure 8
Canadian Mineral Property Portfolio in the United States, 1991-98 – States Accounting for 90% of Canadian Holdings in 1998
Companies of all Sizes Listed on Canadian Stock Exchanges



Source: Natural Resources Canada, based on *MIN-MET CANADA* database for 1992-97 and *Info-Mine* database for 1998, ROBERTSON INFO-DATA Inc., Vancouver, British Columbia, and used under licence.

leading explorationists in that country. Adjusted for inflation, the annual exploration budgets of the larger Canadian-based companies for the United States have grown at an average annual compound rate of about 11% since the early 1990s.

In late 1998, companies of all sizes listed on Canadian stock exchanges held over 700 mineral properties in the United States (Figure 3). They had projects in 31 states, but mainly in the western part of the country in Nevada, California, Alaska, Arizona, Idaho, Montana, Washington, Utah, Wyoming, Colorado, New Mexico, and South Dakota (Figure 8). Nevada alone accounted for almost 300 of their mineral properties, or about 40% of the Canadian portfolio in the United States.

Although Canadian companies have expanded their activities considerably in Latin America, Africa and Asia since the early 1990s, the United States is likely to remain, for the foreseeable future, the foreign country where they hold their largest portfolio of mineral properties. At the end of 1998, the United States accounted for over 20% of all properties held abroad by these companies.

Of all the Canadian-based companies, Teck Corporation, Placer Dome Inc. and Barrick Gold Corporation planned the largest exploration programs in the United States during 1998. Together they planned to spend almost $80 million there. Teck planned to spend much of its $35 million budget for the United States on the Pogo (Stone Boy) gold deposit in Alaska. Placer Dome planned to spend much of its almost $23 million budget for the United States on the Donlin Creek gold project in Alaska and on the Pipeline and South Pipeline gold projects located on the Battle Mountain-Eureka gold trend in Nevada. Barrick planned to spend over $20 million, much of it on further exploration at the Betze-Post, Dee, Meikle and Pinson mines in Nevada.

Latin America and the Caribbean

In 1998, the larger-company mineral exploration market in Latin America and the Caribbean was valued at $1.2 billion (Figure 4), or almost 29% of the $4.0 billion larger-company market worldwide. Latin America accounts for the largest concentration of Canadian mineral exploration activity. During 1998, the larger Canadian-based companies planned to spend over $440 million there. However, this amount represents a decrease of more than $250 million, or over 36%, compared with 1997.

In spite of significant decreases since 1997, the exploration budgets of the larger Canadian-based companies for Latin America and the Caribbean have grown at an average annual compound rate of over 30% between 1992 and 1998. In 1998, these companies held more than 38% of the larger-company market in the region, by far the largest share. In addition, they held the dominant share of the exploration activity in several countries in the region.

At the end of 1998, companies of all sizes listed on Canadian stock exchanges held interests in over 1200 mineral properties in the region. Since 1996, the total number of mineral properties held by Canadian companies in Latin America and the Caribbean has exceeded the number held in the United States (Figure 3).

Mexico

In 1998, the larger-company mineral exploration market in Mexico was valued at over $180 million, or 4.5% of the $4.0 billion larger-company market worldwide. Twenty of the larger Canadian-based companies planned to spend, in total, more than $70 million in that country, equivalent to 40% of the market, and the dominant share. Mexico ranks second as the country of Latin America and the fourth in the world where Canadian companies are the most active (Figure 6).

During 1994, there was a significant increase in the average size of the mineral property portfolio held in Mexico by companies of all sizes listed on Canadian stock exchanges.[6] At the end of 1998, these companies held interests in projects in 18 of the country's 31 states (Figure 9).

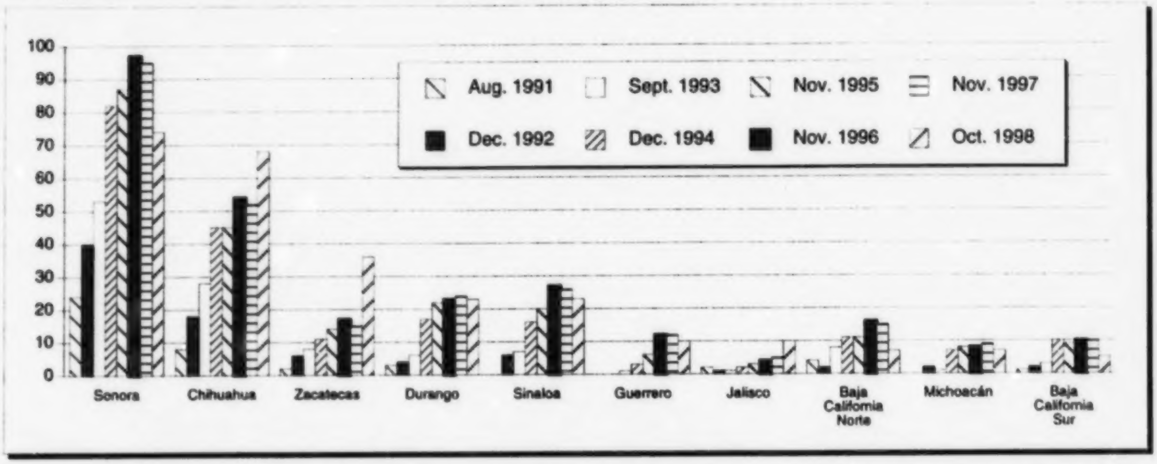
Cambior inc. planned the largest Canadian exploration program in Mexico during 1998. The company planned to spend over $15 million there, most of it on its Cerro San Pedro gold-silver project.

South America

In 1998, the larger-company mineral exploration market in South America was valued at $850 million, or over 20% of the $4.0 billion larger-company market worldwide. Thirty of the larger Canadian-based companies planned to spend about $300 million in total in the region, equivalent to almost 35% of the market there. Canadian companies held the dominant share of the market in Argentina, Bolivia, Chile, Colombia, Guyana and Peru.

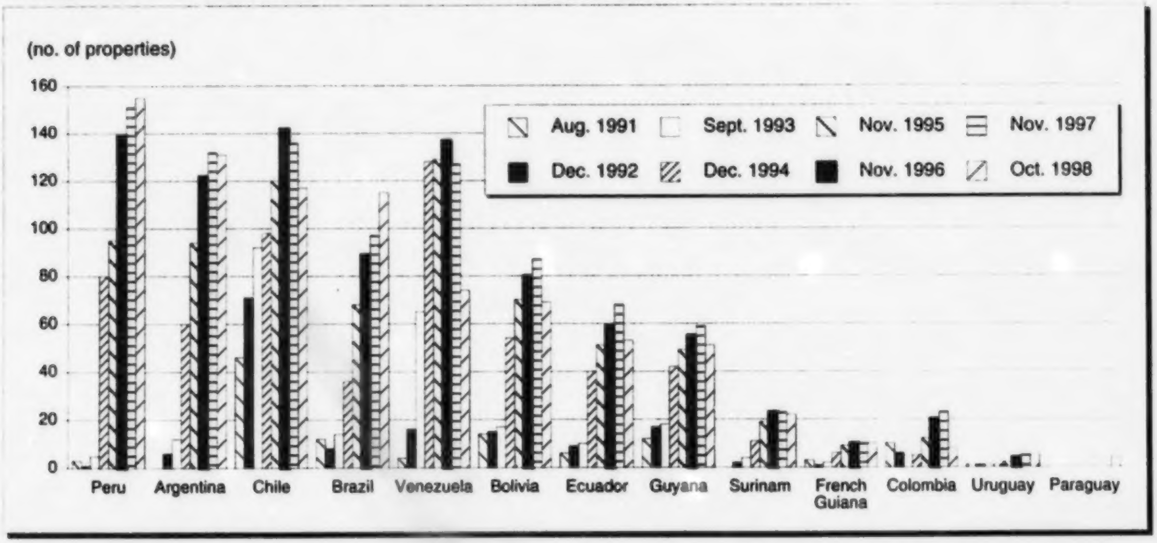
Chile is the country of South America where Canadian-based companies conduct the largest portion of their exploration programs (Figure 6). Chile also ranks third in the world as the country where Canadian companies are the most active. Placer Dome planned to spend a large part of its almost $39 million budget for Chile on the Cerro Casale (Aldebaran) gold-copper project, while Barrick planned to spend about $30 million on the Pascua gold project. Elsewhere in South America, Orvana Minerals Corporation planned to spend almost

Figure 9
Canadian Mineral Property Portfolio in Mexico, 1991-98 – States Accounting for 90% of Canadian Holdings in 1998
Companies of all Sizes Listed on Canadian Stock Exchanges



Source: Natural Resources Canada, based on *MIN-MET CANADA* database for 1992-97 and *Info-Mine* database for 1998, ROBERTSON INFO-DATA Inc., Vancouver, British Columbia, and used under licence.

Figure 10
Canadian Mineral Property Portfolio in South America, by Country, 1991-98
Companies of all Sizes Listed on Canadian Stock Exchanges



Source: Natural Resources Canada, based on *MIN-MET CANADA* database for 1992-97 and *Info-Mine* database for 1998, ROBERTSON INFO-DATA Inc., Vancouver, British Columbia, and used under licence.

$8 million on the Don-Mario gold-copper deposit in Bolivia, Greystar Resources Ltd. planned to spend almost $6 million in Colombia, and Cambior planned to spend over $2 million at the Omai gold mine and the Hicks gold deposit in Guyana.

At the end of 1998, companies of all sizes listed on Canadian stock exchanges held more than 800 mineral properties throughout South America. They held more than 150 properties in Peru, and more than 100 in each of Argentina, Chile and Brazil (Figure 10).

Central America

In 1998, the larger-company mineral exploration market in Central America was valued at about $40 million, or 1% of the $4.0 billion larger-company market worldwide. One dozen of the larger Canadian-based companies planned to spend almost all of that amount. They held the dominant share of the market in Costa Rica, Salvador, Honduras, Nicaragua and Panama.

In 1998, four Canadian-based companies planned the largest exploration programs in five countries of Central America: Placer Dome planned to spend almost $8 million in Costa Rica; Kinross Gold Corporation planned to spend about $0.7 million on the El Dorado and the Potonico gold projects in Salvador; Greenstone Resources Ltd. planned to spend over $7 million at the San Andres gold mine in Honduras, and also planned to spend nearly $11 million at the La Libertad gold mine and almost another $4 million at the Bonanza gold mine, both in Nicaragua; and Teck planned to spend over $1 million at the Petaquilla copper-gold project in Panama.

At the end of 1998, companies of all sizes listed on Canadian stock exchanges held about 100 mineral properties throughout Central America. They held 20 or more in each of Honduras and Panama (Figure 11).

Caribbean

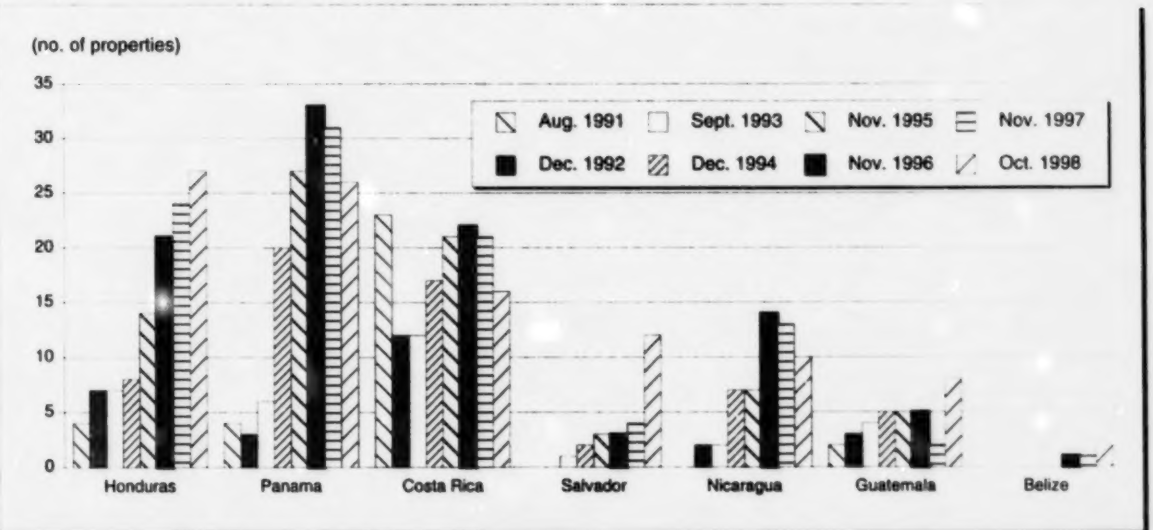
In 1998, the larger-company mineral exploration market in the Caribbean was valued at over $15 million. The larger Canadian-based companies planned to spend $1 million there, equivalent to roughly 7% of the market.

At the end of 1998, companies of all sizes listed on Canadian stock exchanges held about 40 mineral properties in the Caribbean, about half of them in Cuba (Figure 12).

Europe and the Former Soviet Union

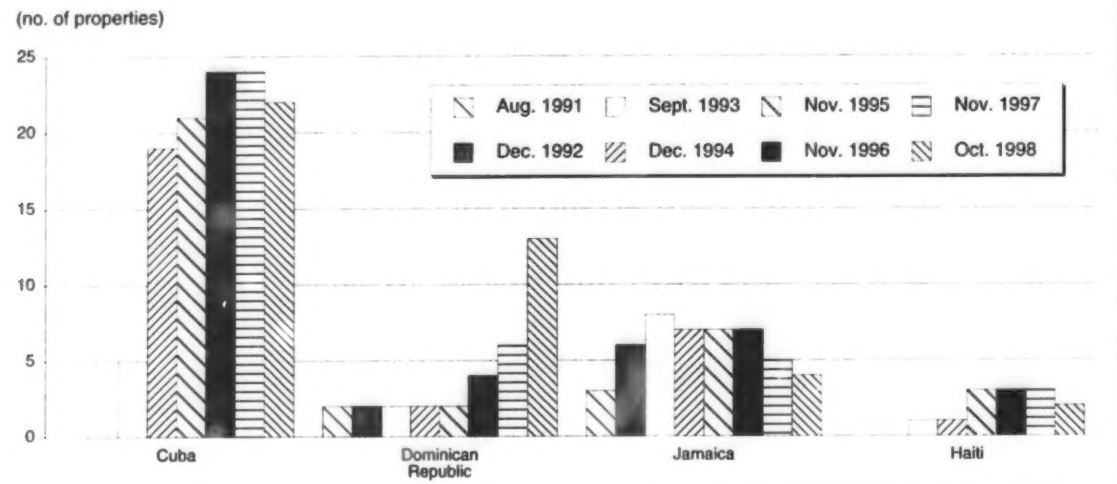
In 1998, the larger-company mineral exploration market in Europe and the former Soviet Union (FSU) was valued at over $190 million (Figure 4), or roughly

Figure 11
Canadian Mineral Property Portfolio in Central America, by Country, 1991-98
Companies of all Sizes Listed on Canadian Stock Exchanges



Source: Natural Resources Canada, based on *MIN-MET CANADA* database for 1992-97 and *Info-Mine* database for 1998, ROBERTSON INFO-DATA Inc., Vancouver, British Columbia, and used under licence.

Figure 12
Canadian Mineral Property Portfolio in the Caribbean, by Country, 1991-98
Countries With Canadian Holdings in 1998
Companies of all Sizes Listed on Canadian Stock Exchanges



Source: Natural Resources Canada, based on *MIN-MET CANADA* database for 1992-97 and *Info-Mine* database for 1998, ROBERTSON INFO-DATA Inc., Vancouver, British Columbia, and used under licence.

5% of the $4.0 billion larger-company market worldwide. The larger Canadian-based companies planned to spend over $90 million there, equivalent to almost half the market. At the end of 1998, companies of all sizes listed on Canadian stock exchanges held about 225 mineral properties in the region (Figure 3).

Western Europe

In 1998, the larger-company mineral exploration market in western Europe was valued at almost $70 million, or roughly 2% of the $4.0 billion larger-company market worldwide. The larger Canadian-based companies planned to spend $25 million there, equivalent to about 37% of the market. They held the dominant share in Greenland and Sweden.

During 1998, three Canadian-based companies planned the largest programs in three countries of western Europe: Dia Met Minerals Ltd. planned to spend almost $2 million on exploration for diamonds in Greenland; Noranda Inc. planned to spend over $2.5 million on grass-roots exploration for zinc-lead deposits in Ireland; and Boliden Limited planned to spend two thirds of its $15 million budget for Europe at, or around, its mining leases in Sweden.

At the end of 1998, companies of all sizes listed on Canadian stock exchanges held almost 90 mineral properties in western Europe. They held more than 10 in each of Sweden, Portugal, Finland and Greenland (Figure 13).

Eastern Europe

In 1998, the larger-company mineral exploration market in eastern Europe was valued at $38 million, or roughly 1% of the $4.0 billion larger-company market worldwide. The larger Canadian-based companies planned to spend about $27 million there, equivalent to almost 70% of the market.

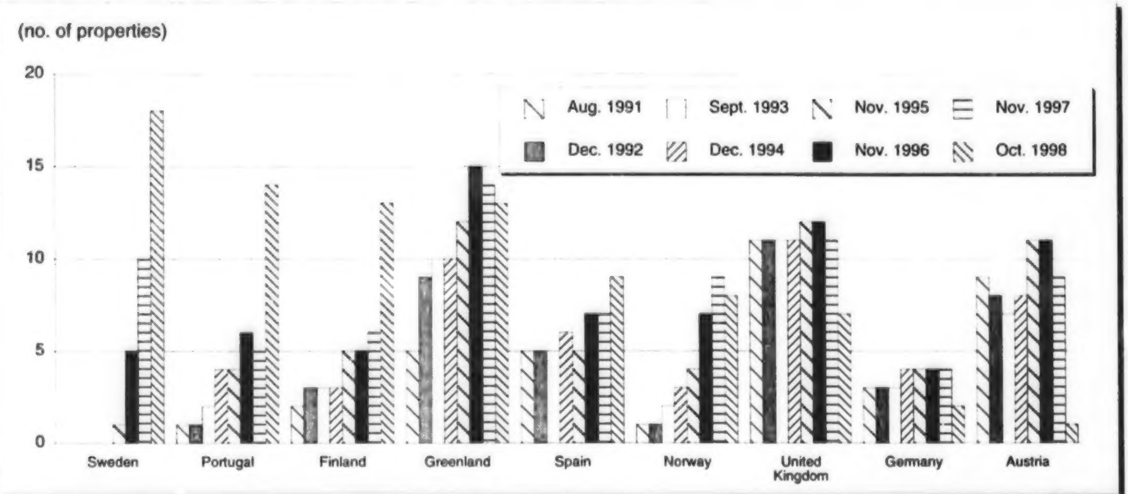
Canadian-based companies held the dominant share of the market and planned the largest programs in four countries of eastern Europe: TVX Gold Inc., alone, planned to spend almost $10 million in Greece, mainly on its Olympias and Skouries deposits; Nebex Resources Ltd. planned to spend $7 million in Albania; Gabriel Resources Limited planned to spend over $4 million in Romania; and Cominco Ltd. planned to spend over $2 million searching for gold in Turkey.

At the end of 1998, companies of all sizes listed on Canadian stock exchanges held about 50 mineral properties in eastern Europe. They held one dozen or more in each of Turkey and Slovakia (Figure 14).

Former Soviet Union

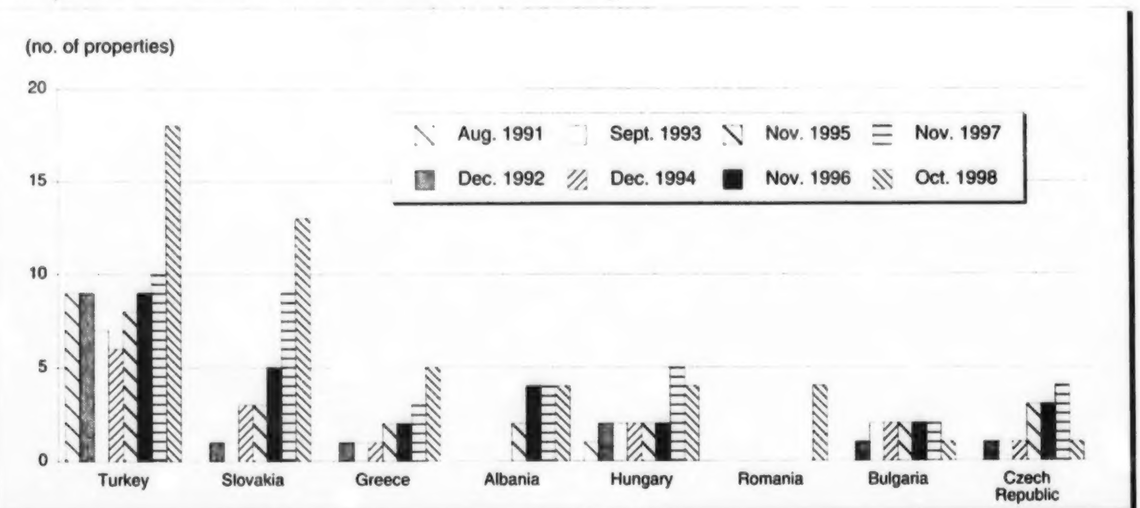
In 1998, the larger-company mineral exploration market in the FSU was valued at over $70 million, or

Figure 13
Canadian Mineral Property Portfolio in Western Europe, 1991-98 – Countries Accounting for 95% of Canadian Holdings in 1998
Companies of all Sizes Listed on Canadian Stock Exchanges



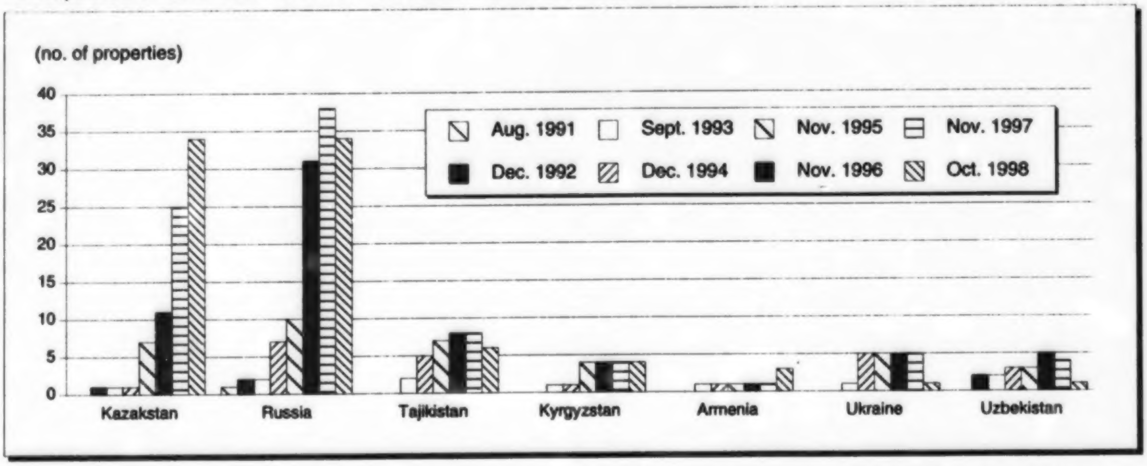
Source: Natural Resources Canada, based on *MIN-MET CANADA* database for 1992-97 and *Info-Mine* database for 1998, ROBERTSON INFO-DATA Inc., Vancouver, British Columbia, and used under licence.

Figure 14
Canadian Mineral Property Portfolio in Eastern Europe, 1991-98
Countries With Canadian Holdings in 1998
Companies of all Sizes Listed on Canadian Stock Exchanges



Source: Natural Resources Canada, based on *MIN-MET CANADA* database for 1992-97 and *Info-Mine* database for 1998, ROBERTSON INFO-DATA Inc., Vancouver, British Columbia, and used under licence.

Figure 15
Canadian Mineral Property Portfolio in the Former Soviet Union, by Country, 1991-98
Companies of all Sizes Listed on Canadian Stock Exchanges



Source: Natural Resources Canada, based on *MIN-MET CANADA* database for 1992-97 and *Info-Mine* database for 1998, ROBERTSON INFO-DATA Inc., Vancouver, British Columbia, and used under licence.

roughly 2% of the $4.0 billion larger-company market worldwide. The larger Canadian-based companies planned to spend over $35 million in these countries.

Since the early 1990s, there has been growing Canadian interest in participating in mineral opportunities in the FSU. At the end of 1998, companies of all sizes listed on Canadian stock exchanges held interests in over 80 mineral properties in seven countries of the FSU (Figure 15).

Russia is by far the country of the FSU where Canadian companies are the most active. In 1998, a dozen of these companies planned to spend almost $27 million in total on exploration there, about the same amount as in 1997 and the dominant share of the market. The number of properties held in Russia by companies of all sizes listed on Canadian stock exchanges increased significantly starting in 1996 and now stands at over 30. Archangel Diamond Corporation, with the largest exploration budget for Russia, planned to spend over $13 million exploring for diamonds in the Verkhotina licence area.

Kazakstan also has become increasingly attractive to Canadian companies. During 1998, the portfolio of mineral properties held in that country by companies of all sizes listed on Canadian stock exchanges increased to over 30.

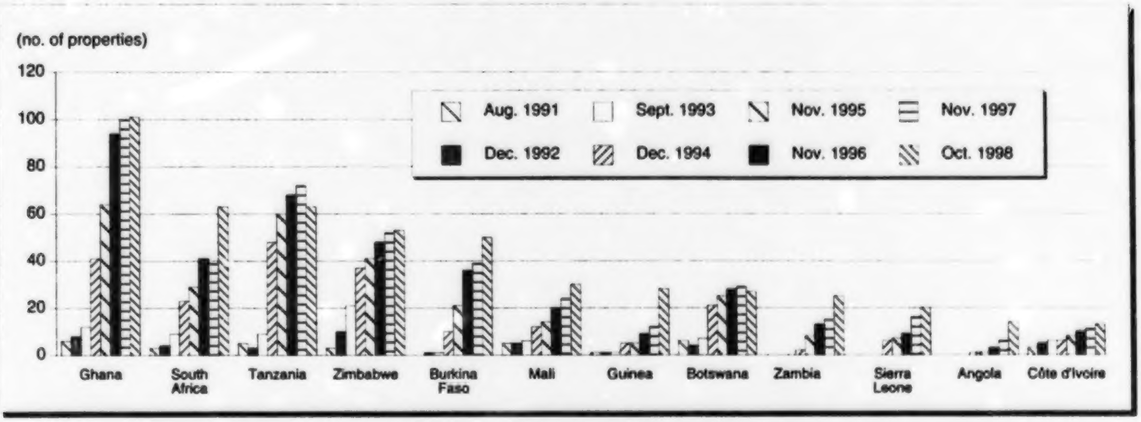
Africa and the Middle East

In 1998, the larger-company mineral exploration market in Africa and the Middle East was valued at almost $710 million (Figure 4), or almost 18% of the $4.0 billion larger-company market worldwide. The larger Canadian-based companies planned to spend $165 million in Africa, equivalent to over 23% of the market on that continent.[7,8] In addition, they planned to spend about $0.6 million in the Middle East.

During 1998, nine of the larger Canadian-based companies planned the largest mineral exploration programs in eight countries of Africa: Sutton Resources Ltd. planned to spend over $30 million in Tanzania; SouthernEra Resources Limited planned to spend over $17 million exploring for diamonds in Angola; Tenke Mining Corp. planned to spend $14 million and Banro Resource Corporation planned to spend $11 million in the Democratic Republic of the Congo; High River Gold Mines Ltd. planned to spend $7 million on its Taparko gold project in Burkina Faso; Samax Gold Inc. planned to spend $0.7 million in the Congo; Messina Diamond Corporation planned to spend $7 million in Lesotho; Etruscan Resources Inc. planned to spend almost $6 million in Niger; and DiamondWorks Ltd. planned to spend $0.4 million in Sierra Leone.

Between 1992 and 1998, the number of mineral properties held in Africa by companies of all sizes listed on Canadian stock exchanges grew at an average annual compound rate of over 50%. As a result, at the end of 1998, these companies held interests in over 600 mineral properties in 34 countries there. They held interests in about 100 properties in Ghana, in about 60 in each of South Africa and Tanzania, and in about 50 in each of Zimbabwe and Burkina Faso (Figure 16).

Figure 16
Canadian Mineral Property Portfolio in Africa, 1991-98 – Countries Accounting for 80% of Holdings in 1998
Companies of all Sizes Listed on Canadian Stock Exchanges



Source: Natural Resources Canada, based on *MIN-MET CANADA* database for 1992-97 and *Info-Mine* database for 1998, ROBERTSON INFO-DATA Inc., Vancouver, British Columbia, and used under licence.

Although gold is the primary target of Canadian companies in Africa, there is nonetheless a considerable variety in the mineral commodities that they seek there. Some of the commodities of interest to Canadians on that continent are not currently produced in Canada or there is not much exploration for them in this country.

Asia-Pacific

In 1998, the larger-company exploration market in Asia-Pacific was valued at over $1.1 billion (Figure 4), or roughly 28% of the $4.0 billion larger-company market worldwide. The market in Asia-Pacific has become almost as large as the one in Latin America. The larger Canadian-based companies planned to spend about $100 million in the region, equivalent to roughly 9% of the market there. At the end of 1998, companies of all sizes listed on Canadian stock exchanges held interests in over 450 mineral properties in the region (Figure 3).

Southeast Asia

In 1998, the larger-company mineral exploration market in Southeast Asia was valued at over $360 million, or 9% of the $4.0 billion larger-company market worldwide. The larger Canadian-based companies planned to spend over $70 million in Southeast Asia, equivalent to almost 20% of the market there. They held the dominant share of the market in each of Myanmar, Papua New Guinea and Thailand.

In Indonesia, eight of the larger Canadian-based companies planned to spend $30 million in total, equivalent to 15% of the more than $190 million exploration market in that country. Inco Limited alone planned to spend almost $8 million on grass-roots exploration there.

At the end of 1998, companies of all sizes listed on Canadian stock exchanges held almost 270 mineral properties in Southeast Asia. They held over 160 in Indonesia and about 50 in the Philippines (Figure 17).

East Asia

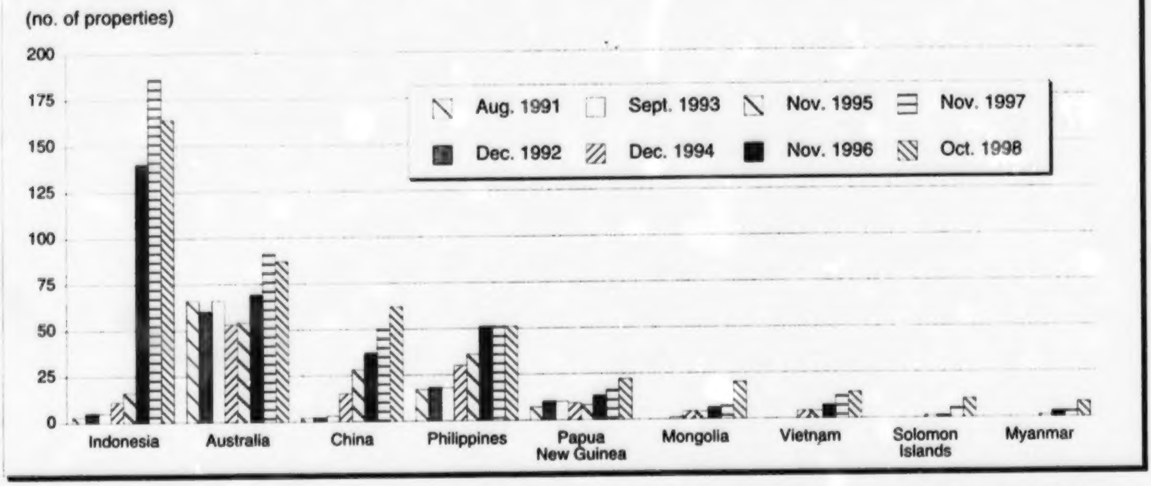
In 1998, the larger-company mineral exploration market in east Asia, which includes China, Japan, Mongolia, Taiwan and South Korea, was valued at about $37 million, or 1% of the $4.0 billion larger-company market worldwide. The larger Canadian-based companies planned to spend over $7 million there, equivalent to about 20% of the market.

Over the past four years, China has become increasingly attractive to Canadian mining companies. In late 1998, companies of all sizes listed on Canadian stock exchanges held interests in over 60 mineral properties in that country (Figure 17).

South Pacific

In 1998, the larger-company mineral exploration market in the South Pacific was valued at over $710 million, or 18% of the $4.0 billion larger-

Figure 17
Canadian Mineral Property Portfolio in Asia-Pacific, 1991-98 – Countries Accounting for 95% of Canadian Holdings in 1998
Companies of all Sizes Listed on Canadian Stock Exchanges



Source: Natural Resources Canada, based on *MIN-MET CANADA* database for 1992-97 and *Info-Mine* database for 1998, ROBERTSON INFO-DATA Inc., Vancouver, British Columbia, and used under licence.

company market worldwide. Australia accounted for almost all of that market.

The larger Canadian-based companies planned to spend about $20 million in the region in 1998, all of it in Australia. The larger Canadian-based companies held about 3% of the market in that country.

At the end of 1998, companies of all sizes listed on Canadian stock exchanges held over 100 properties in the South Pacific, of which almost 80% were in Australia (Figure 17).

SUMMARY AND OUTLOOK

During 1996, a record amount of equity financing was raised in Canada for exploration companies listed on Canadian stock exchanges. As a result, these companies had the capital to conduct, during 1997, more mineral exploration programs worldwide than those of any other nation. In spite of the subsequent uncertainty in capital markets, worldwide exploration expenditures were remarkably close to budgets during 1997.

In 1997 and 1998, it became progressively more difficult to raise risk capital. As a result, worldwide exploration programs in 1998 were curtailed by about one third compared with those of 1997. In 1998, in spite of continuing uncertainty in global markets, the proportion of exploration budgets allocated to Canada stood at almost 11%, slightly larger than in 1997. In addition, Canadian-based companies conducted almost one third of the world's mineral exploration programs, more than any other nation.

Canadian companies consolidated their position in the Americas during 1998. For the first time, they became the dominant explorationists in the United States, accounting for almost half of the activity there. Furthermore, they continued to conduct the largest share of exploration programs, not only in Canada, but also in Mexico, South America, Central America and Europe. Although Canadian companies have diversified their portfolio of mineral projects to well over 100 countries, Canada remains the country where they are, by far, the most active.

Investor uncertainty continues to depress exploration finance markets, and a return to the record levels of financing raised in Canada in 1996 for exploration worldwide is not yet in sight. A number of multinationals have announced sizeable reductions in exploration programs for 1999. The level of junior company exploration activity around the world will continue to decline until the demand for mineral commodities rises, their prices increase in response, and investor confidence is restored. In the meantime, Canadian companies are likely to continue to dominate mineral exploration, especially in the Americas.

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1 Most of the information on the larger-company mineral exploration market worldwide is based on *Corporate Exploration Strategies: A Worldwide Analysis*, published annually by the Metals Economics Group, Halifax, Nova Scotia (tel. (902) 429-2880).

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Note: Information in this review was current as at early March 1999.

Aluminum

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Prices in aluminum markets continued the downward trend started in the last quarter of 1997 as the economic turmoil in world financial markets continued to put a damper on business confidence worldwide. Although demand in North America and Europe increased, the downturn in Asian economies resulted in 1% less demand worldwide. Average production rates were higher in 1998, reflecting decisions by some producers to restart idled capacity and to add new capacity at existing smelters. As could be expected, this placed downward pressure on prices. Should current low prices for aluminum continue, high-cost producers and those with older technology or high debt loads may face an increasingly difficult situation in 1999.

Aluminum cash settlement prices on the London Metal Exchange (LME) started 1998 at just over US$1500/t (US69¢/lb) and continued a downward trend to end the year at US$1240/t (US56¢/lb). The average price during the year was US$1355/t (US62¢/lb) compared to an average of US$1599/t (US73¢/lb) in 1997. Primary aluminum stocks on the LME started the year at 622 000 t and declined steadily until August when they reached 453 000 t. Stocks then began to rise to end the year at about 636 000 t. The International Primary Aluminium Institute (IPAI) reported that unwrought aluminum inventories held by IPAI members increased slightly over the course of the year to 1.682 Mt in December 1998, compared to 1.636 Mt in December 1997. Together the aggregated unwrought IPAI and LME stocks decreased until July to reach their lowest level since March 1991. Stocks then increased to end the year at about the same level as at the start of the year.

Canadian Developments

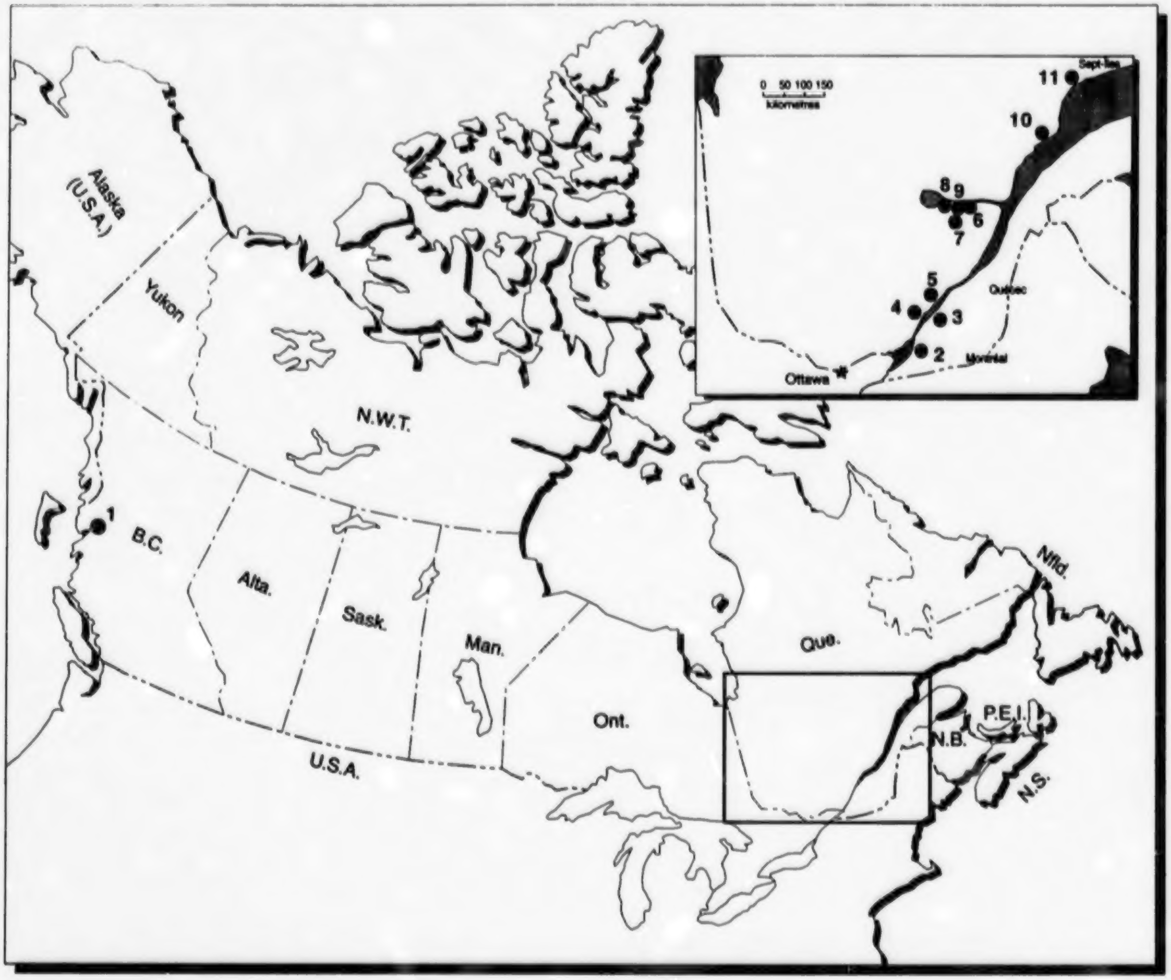
The production of primary aluminum increased by 2% to 2.374 Mt in 1998, compared to 2.327 Mt in 1997, ranking Canada third after the United States and Russia in terms of world production. The value of Canadian production is estimated at $4.8 billion, compared to 1997 production of $5.2 billion, reflecting the decrease in aluminum prices.

Canada is the second largest aluminum-exporting country in the world after Russia. Canadian exports of primary smelter products in 1998 fell to 1.856 Mt valued at $4.285 billion, compared with 1.886 Mt valued at $4.5 billion in 1997. Of this amount, exports to the United States totalled 1.44 Mt valued at $3.39 billion, compared to 1.41 Mt valued at $3.44 billion in 1997.

British Columbia's Power for Jobs Strategy makes surplus electrical power available to industry, under flexible terms and conditions, to create jobs and investment. One of the industries the province has targeted is aluminum. In August 1997, the province signed an agreement with Alcan Aluminium Limited that makes competitively priced power available to Alcan in return for adding smelting capacity to its Kitimat plant in northwestern British Columbia. In 1998, B.C. signed memoranda of understanding with Alumax Inc., Alcoa Inc. and Columbia Ventures Corporation to undertake planning and feasibility studies for the development of primary aluminum production plants and value-added facilities. (For further information, visit the Government of British Columbia's web site at http://www.gov.bc.ca.)

The Alcan and Columbia Ventures feasibility studies are expected to be completed in mid-to-late 1999. Alcoa has decided to suspend its feasibility study until market conditions improve. (Alumax has since been acquired by Alcoa.) The province is continuing to pursue discussions with other aluminum producers with the objective of securing investment in British Columbia.

Figure 1
Aluminum Smelters, 1998



SMELTER	COMPANY	CAPACITY (t/y)
1. Kitimat	Alcan	272 000
2. Beauharnois	Alcan	48 000
3. Bécancour	A.B.I.	372 000
4. Shawinigan	Alcan	84 000
5. Lauralco	Alcoa Lauralco	225 000
6. Grande-Baie	Alcan	180 000
7. Laterrière	Alcan	204 000
8. Isle-Maligne	Alcan	73 000
9. Arvida	Alcan	232 000
10. Baie-Comeau	Canadian Reynolds Metals	400 000
11. Alouette	Alouette	230 000

Alcan has made adjustments in its global operations to maintain its position as a low-cost supplier of bauxite, alumina and aluminum and to focus on its core business. (Additional information on Alcan can be obtained through its web site at http://www.alcan.com/.)

In March, Alcan started construction of a new 375 000-t/y primary aluminum smelter at Alma, Quebec, to replace the 73 000-t/y Isle-Maligne smelter and add new capacity. The smelter will employ about 650 people (including 425 from the existing Isle-Maligne smelter), and will cost approximately $2.2 billion. The smelter is expected to start producing metal in the fall of 2000 and is expected to reach full capacity in mid-2001.

In November, Alcan announced that it had signed a 10-year, multi-billion-dollar agreement with General Motors Corporation. This agreement will ensure the supply of metal from Alcan to General Motors at a competitive cost and enable both companies to jointly explore new uses for aluminum, including aluminum-intensive vehicles. The agreement will ensure the long-term availability and sales of metal at a stable cost through new smelter investment and the use of third-party financial instruments.

Alcan also signed an 18-year agreement with its unionized employees in Quebec that commits parties to work together to resolve labour conflicts without resorting to traditional pressure tactics. This agreement is expected to result in increased stability in union/company relations.

In February 1998, Reynolds Metals Company announced that it had completed the sale of its Canadian aluminum extrusion plants in Richmond Hill, Ontario, and Sainte-Thérèse, Quebec, to Tredegar Industries. These plants manufacture aluminum products used in the construction, transportation, electrical, machinery and equipment, consumer durables, and climbing equipment markets.

U.S. aluminum producer Alcoa returned to Canada in 1998 with its acquisition of Alumax. Alcoa now owns the 230 000-t/y Lauralco smelter and has a 24.95% interest in the 372 000-t/y Aluminerie de Bécancour Inc. (A.B.I.) smelter. Other partners include: Pechiney Reynolds Québec Inc. (50.1%), which is a joint venture of Pechiney Corporation of France and Reynolds Metals Company Limited of the United States, and Canadian Reynolds Metals, Company Limited (24.95%).

The merger announced in November 1998 between Alusuisse Lonza Group Ltd. of Switzerland and Viag Aktiengesellschaft of Germany is not expected to change Viag's 20% participation in the 230 000-t/y Alouette smelter at Sept-Îles. Other partners include: Aluminium Austria Metall Québec (20%), VAW Aluminium Canada (20%), Hoogovens Aluminium Québec Inc. (20%), Société générale de financement du Québec (20%), Kobe Aluminium Canada Inc. (13.33%), and Marubeni Québec Inc. (6.66%).

The Aluminium Association of Canada is a non-profit organization formed by Canada's five aluminum producers: Alcan Aluminium Limited, Aluminerie Alouette Inc., Aluminerie de Bécancour Inc., Alcoa Aluminerie Lauralco Inc., and Canadian Reynolds Metals Company, Limited. The Association provides a link between the Canadian aluminum industry, aluminum users, the public and government. (Web sites of the primary aluminum producers in Canada can be accessed through the Aluminium Association of Canada's web site at http://www.aia.aluminium.qc.ca.)

World Developments

Due to decreasing prices and competitive pressures, producers have increasingly focused on cost reductions and have rationalized production to take advantage of economies of scale. This has not gone on without some overall effect on existing operations. Some unions and companies have struggled to establish new labour contracts, while other companies have amalgamated operations, closing some plants and selling others to refocus on lower-cost operations. In general, many companies have made increases in productivity and production to maintain cash flows with the current low prices. Two large mergers, Alcoa Inc. with Alumax Inc. and Viag with Alusuise, will likely result in continued readjustment among affected operations during the coming year.

Large consumers of aluminum often invest in primary metal joint ventures, taking their share of the metal for their own use. These arrangements and long-term supply agreements between producers and consumers are restructuring parts of the supply chain to reduce short-term demand to ensure a continuous supply of raw material at a low average cost. Primary producers are countering the effect of lower short-term primary aluminum prices through these agreements and by focussing on value-added operations to produce metal products with higher margins.

World production of primary and secondary aluminum reached an estimated 29.5 Mt in 1998, of which 22.4 Mt was primary material. Total Western World primary smelter production reached an estimated 16.5 Mt in 1998, up from 16.2 Mt in 1997.

Among IPAI members, the primary aluminum daily production rate increased from an average of 54 500 t in January to 55 500 t in December. The average rate for all of 1998 was 54 700 t/d compared with 53 400 t/d in 1997.

The IPAI reported that the world's total alumina production capacity increased to 48.2 Mt in 1998 from 47.5 Mt in 1997. World alumina production also rose to 45.0 Mt in 1998 from 43.3 Mt in 1997. (Further information on the IPAI can be obtained through its web site at http://www.world-aluminum.org.)

United States

The Aluminum Association reported that the United States, the world's largest producer of primary and secondary aluminum, produced a total of 3.712 Mt of primary aluminum in 1998, up from 3.603 Mt in 1997. In addition to primary production, secondary aluminum production is estimated at 3.3 Mt in 1998, representing roughly 45% of the total secondary aluminum produced worldwide. (Further information on the U.S. aluminum industry can be found on the Internet at http://www.aluminum.org/.)

Alcan has made several adjustments to its U.S. operations. It sold its Shelbyville, Tennessee, aluminum alloys plant to Imco Recycling Inc. The plant has a capacity to produce 55 000 t/y of specification alloys. A study on expanding its Sebree, Kentucky, smelter is expected to be completed early in 1999.

National Southwire Aluminum Co. started an expansion of its 188 000-t/y Hawesville, Kentucky, smelter. A fifth potline and solid waste disposal facility will be added to expand the smelter's capacity by 50 000 t to 238 000 t/y.

During the year, Reynolds Metals Company restarted idle capacity at its smelters in Massena, New York (41 000 t/y), Troutdale, Oregon (94 000 t/y), and Longview, Washington (47 000 t/y). These restarts will bring most of Reynolds' idled capacity back on stream.

In March, Alcoa Inc. announced that it was acquiring Alumax. Alcoa is the world's largest producer of aluminum and alumina with 250 operating locations in 30 countries. The combined company has primary aluminum production capacity of 3.3 Mt/y, approximately 100 000 employees, and sales of over US$16 billion. Since the acquisition, Alcoa has sold its cast plate business to Century Aluminum and has made adjustments in the combined company, reducing production in some locations and increasing it in others for greater efficiencies. Alcoa has indicated that it will look for other acquisitions and joint ventures in 1999. (For further information on Alcoa, visit its web site at http://www.alcoa.com/.)

Noranda Inc. plans to build a US$240 million aluminum foil plant in the U.S. Midwest while it phases out production in ageing factories in Tennessee, Arkansas and North Carolina. Noranda expects to pick a site within six months and to begin production two years later. Early in 1999, Noranda's Norandal USA, Inc. business unit concluded negotiations to sell its sheet rolling mill in Scottsboro, Alabama, to Michigan Avenue Partners. The plant produces painted and bare aluminum sheet and welded aluminum tube with an annual capacity of 181 000 t. Michigan Avenue Partners is a privately held investment firm based in Chicago, Illinois.

The New York Mercantile Exchange (NYMEX) has proposed a new aluminum contract. The Board of the Exchange approved aluminum futures and options contracts late in 1998. The Exchange expects to have contracts trading in the second quarter of 1999. (Further information can be obtained by visiting the Exchange's web site at http://www.nymex.com.)

Trinidad and Tobago

On November 12, 1998, Norsk Hydro Produksjon a.s. signed a project agreement with the Government of Trinidad and Tobago to support a 474 000-t/y smelter at Point Lisas on the west coast of Trinidad in two equal stages. The first phase of the project to produce 237 000 t/y would cost US$1.5 billion and would include a modern gas-fired power plant, harbour, a carbon anode paste plant and a cast house. The plant would use the best available technology to ensure high-quality operations at a low operating cost. Although a decision was still expected on the main study early in 1999, the company indicated in early 1999 that it was contemplating a delay in construction. Nevertheless, if all approvals are obtained in 1999, metal production could start in 2002.

South America

After three unsuccessful attempts to privatize Corporacion Venezolana de Guayana (CVG), the Venezuelan government indicated in early 1999 that it was planning to invest $200 million to make its Puerto Ordaz complex more saleable to private investors. Late in 1998, company directors approved the shutdown of two older potlines at its Alcasa smelter, reducing production by 50 000 t to 170 000 t/y.

CVG also entered into an agreement in October 1998 to sell all of the Class A common stock it holds in Baltimore-based Wells Aluminum Corporation back to that company for an aggregate purchase price of $3.1 million. Wells Aluminum is a fabricator of soft alloy aluminum products with seven facilities in the midwestern and southeastern United States.

Europe

In November, Alusuisse Lonza Group Ltd. (Algroup) of Switzerland and Viag Aktiengesellschaft (Viag) of Germany announced plans to merge to create the fourth largest integrated aluminum producer with sales of more than 50 billion marks (US$31 billion).

This merger will require approvals from shareholders and regulatory authorities, and will take until mid-1999 to be completed. The companies intend to integrate their businesses to optimize the operation from bauxite mining to rolling operations and production of fabricated products.

Alcan Aluminium Limited announced, in January 1999, an agreement in principle with Glencore International AG of Baar of Switzerland for the sale of Alcan's Aughinish alumina refinery in Ireland. This 1.3-Mt/y alumina refinery located near Limerick, Ireland, produced alumina that is surplus to Alcan's needs and the sale reduces Alcan's alumina cost.

In January 1998, Gränges AB announced that it had reached an agreement to sell Gränges Metall AB, the operator of the company's 140 000-t/y Sundsvall aluminum smelter, to the management of Glencore Sverige AB. Glencore is an international group active in the mining, smelting and trading of metals and minerals. The new owners have signed a 10-year agreement with Glencore International AG of Barr, Switzerland, for the tolling of billet and slab. At the same time, Gränges AB entered an agreement to purchase a major portion of the group's requirements for billet and slab from Glencore. (For further information, visit Gränges' web site at http://www.graenges.se/index2.htm.)

In May, Norsk Hydro ASA's subsidiary, Hydro Aluminium a.s., indicated that it had restarted all of its idle capacity and that it expected to launch an international expansion program to increase its annual capacity to 1.4 Mt by 2005. Norway, Trinidad, Quatar and Poland were suggested as likely locations for this expansion. Although the company announced plans for the Trinidad expansion, lower profits announced early in 1999 may result in a delay. (For further information, visit Norsk Hydro's web site at http://www.hydro.com/.)

A modernization and expansion of Hydro Aluminium's Ardal aluminum and carbon plant, which started in 1997, is nearing completion. Modernization and a new production line for baked electrodes will increase capacity for electrodes from 110 000 t/y to 160 000 t/y. The aluminum potlines were also lengthened, increasing their capacity by 12 000 t/y. In addition, the casting facilities have been upgraded, resulting in an increase in capacity to 300 000 t/y.

Nordic Aluminum Corporation of Iceland (Nordurál), a subsidiary of U.S. Columbia Ventures Corporation, completed construction of its 60 000-t/y aluminum smelter. The smelter, at Grundartangi in western Iceland, started production in June and was working at near capacity by year-end. Due to tight power supplies in Iceland late in 1998, Columbia Ventures' original plan to increase production to 90 000 t/y will be delayed until future power supplies are assured. Iceland's national power company, Landsvirkjun, has recently doubled its generating capacity through hydro-electric power and geothermal projects, and indicated early in 1999 that it was prepared to double its capacity again. (For further information, visit the company's web site at http://www.lv.is.)

When Pechiney SA was privatized in 1995, the Government of France kept 10.5% of the shares. In 1998, these residual shares were sold to banks, investment dealers, the Compagnie générale des matières nucléaires (COGEMA) and the French power company Électricité de France. Pechiney expected to restart idled capacity at its 120 000-t/y St. Jean de Maurice smelter and its 60%-owned, 150 000-t/y Aluminium de Grèce smelter by the end of 1998.

With the downward pressures on aluminum prices, the topic of European Union (EU) tariffs again came to the forefront. A 6% tariff is imposed on aluminum imported to the EU by North American and Gulf producers. A report by the Organization for Economic Co-operation and Development estimated that, in 1995, European consumers paid an extra US$472 million to use the metal.

Russia

Sayan Aluminium will modernize its plant in Siberia to reduce energy costs and expand primary aluminum smelting capacity by 15% to 380 000 t/y. The project will incorporate foil and strip mills into the smelter.

Russia's biggest aluminum smelter, the Bratsk Aluminum plant, has announced plans to expand its capacity by 50 000 t to 900 000 t/y by 2000. Planning is also under way for a modernization of the facilities.

Volgograd Aluminium expected to produce 130 000 t of aluminum in 1998, up from 119 000 t in 1997. The company cut production due to shortages of raw materials, and is also planning to modernize the smelter.

In March, Daewoo Corporation sold its 10% stake in the Krasnoyarsk aluminum smelter for approximately US$30 million. The Krasnoyarsk smelter in southern Siberia produces 728 000 t/y, or 28% of Russia's output. The sale was prompted by uncertainty in the Russian economy and the financial problems of the smelter.

Middle East

In June, Dubai Aluminium Company Limited (Dubal) announced that it had awarded a contract for the provision of power equipment for its US$725 million Condor project. This project (following its Falcon expansion project completed in 1997) will now

increase its smelter's capacity by 35% to 525 000 t/y. The company had raised US$410 million in financing by September and expected to complete the project in 2000.

In Iran, the first phase of the new Al-Mahdi aluminum smelter located near the port of Bandar Abbas had difficulty meeting its intended output of 110 000 t/y due to a lack of funds to complete the first phase of the project. Its output was expected to be only 10 000 t.

Alcoa signed a letter of intent in June with The Aluminium Company of Egypt (Egyptalum) to study the feasibility of forming a joint venture, or of Alcoa acquiring an interest in its aluminum business. The study will include a review of the technology and management of the operations. Egyptalum has a 180 000-t/y smelter and a rolling mill at Aluminium City in Nag-Hammadi, Egypt.

Asia

China's production of aluminum was reported to have risen by over 16% in 1997 and its exports of unwrought aluminum in 1998 were up almost 25% to 436 251 t compared to the previous year. The increase was much higher during the early part of the year (65% to June). The decrease in world aluminum prices, coupled with increased internal prices and demand from infrastructure projects, is expected to reduce exports in 1999. Aluminum demand strengthened in China because of stricter enforcement of customs rules on imports. China removed requirements for export licences and quotas on aluminum and aluminum alloys in mid-1998, which will allow more firms to export aluminum. However, only limited increases in exports are expected due to a 30% tariff.

In October, Alcoa announced that it had signed a Memorandum of Understanding with China's State Nonferrous Metals Industry Administration to study the feasibility of forming a joint venture on refining, smelting and fabricating facilities. The study will take six to twelve months to complete.

Continuing turmoil in Asia and in world financial markets has created a shortage of funds for some Chinese aluminum producers' expansion plans, and low prices and high energy costs have caused others to cut production. However, other producers have embarked on expansions of existing plants:

- China's Yunnan aluminum plant installed and started up additional capacity to increase its capacity from 40 000 t/y to 60 000 t/y, and plans to reach a capacity of 120 000 t/y in the second half of 1999.

- China's Qingtongxia aluminum plant in Ningxia plans to begin a third expansion phase to double its capacity to 200 000 t/y in the next 30 months. Bank loans for this work were approved late in 1998.

- China Steel Aluminum Corp. is expanding its capacity by 65% to 122 000 t/y with expected completion in June 1999.

- Xin'an's aluminum smelter in Lianoming Province is planning to double its capacity to 55 000 t/y.

- The Zhongzhow alumina plant in Henan started an expansion of 70 000 t/y and plans to reach a capacity of 300 000 t/y by 2000.

In Indonesia, water shortages reduced the power available to Nippon Asahan Aluminum Co.'s Indonesian smelter. Its production is expected to be around 105 000 t, a rate that is about one half of 1997's production level.

Africa

Alcan Aluminium Limited reached an agreement with the Government of Ghana in March to purchase an additional 35% of Ghana Bauxite Company. This agreement increases Alcan's interest to 80% with the Government of Ghana retaining 20%. Alcan expects to expand its bauxite production to 1 Mt/y.

A joint venture comprising Billiton plc (47%), Industrial Development Corporation of South Africa (24%), Mitsubishi Corporation (25%) and the Mozambique government (4%) started construction in July on its 250 000-t/y Mozal smelter in Maputo, Mozambique. The project is a duplicate of Billiton's Alusaf Hillside smelter in South Africa and will use an updated version of Pechiney technology. This US$1.2 billion smelter is expected to produce aluminum ingot in 2000 and to reach its full capacity in 2001. (For further information on the Mozal project, visit the web site at http://www.mozal.com.)

The Government of Mozambique signed a Memorandum of Understanding to carry out a feasibility study for the development of a 240 000-t/y smelter project in Beira on the coast of Mozambique. The study, sponsored by the U.S. Trade and Development Agency, is expected to be completed late in 1999.

In October, the Government of Guinea acquired the 51% it did not already own in the Kimbo bauxite mine and the Fria alumina refinery held by Frialco. The government then solicited bids for privatization of the mine and the 600 000-t/y Fria alumina refinery with a closing date early in 1999. New investment is required to reduce operating costs and to bring the facilities up to current standards.

Insufficient rainfall in Ghana again resulted in Kaiser Aluminum & Chemical Corporation's 90%-

owned Volta Aluminium Company Limited (Valco) smelter operating only one potline during much of 1998. However, rainfall late in the year increased available power supplies from the Volta River Authority, allowing Valco to increase output. The company expects to operate three of five potlines during 1999, which will produce 120 000 t of the smelter's rated capacity of 200 000 t/y.

India

In June, Alcan announced that a public offer for the purchase of an additional 20% of the shares of Indian Aluminium Company, Limited (Indal) had been completed. Alcan now owns a majority and controlling interest (54.6%) in Indal. Alcan joined Indal and Hydro Aluminium a.s. as an equity partner in the proposed $1 billion Utkal export-oriented alumina project. Alcan has provided the technical services for the feasibility study as well as the technology for the proposed joint venture to be known as Utkal Alumina International Ltd. The proposal is to set up a 1-Mt/y greenfield alumina plant in the state of Orissa.

Early in 1998, India's Cabinet approved an expansion of the government-owned National Aluminium Co. Ltd.'s (Nalco) capacity to 345 000 t/y from 230 000 t/y. The cost of this work is expected to be around US$528 million. However, Nalco experienced problems with power tripping and excessive heat in its existing plant early in 1998 and its production suffered. Its output for 1998 is expected to fall by about 50 000 t with a corresponding increase in the export of its alumina. The company also plans to double the capacity of its bauxite mines at Panchpatmalli to 1.58 Mt/y and of its alumina refinery at Damanjodi to 4.8 Mt/y.

Australia

In February, Alcan South Pacific Pty Ltd. and Comalco Aluminium Ltd. signed an agreement to integrate their operations on Western Cape York Peninsula. Alcan's bauxite mining operations at Ely in North Queensland, Australia, will be integrated with existing Comalco infrastructure in Wepa, approximately 20 km from the Ely mine site. Economies of scale will ensure lower costs for Alcan's alumina refinery at Gladstone in Queensland and at other refineries around the world. Lower costs and additional revenues resulting from economies of scale and from the provision of mining services will accrue to Comalco.

Tomago Aluminium Company Pty Limited announced that a program to increase its production capacity by 10% to 440 000 t/y was on schedule for completion by early 1999. Production at the smelter was increased by expanding a third potline. Tomago Aluminium is a joint venture between Gove Aluminium Finance Limited (36.05%), Pechiney Pacific Pty Limited (36.05%), VAW Australia Pty Limited and VAW of America Inc. (12.4%), and TOA Pty Limited (15.5%). (For further information on Tomago Aluminium, visit its web site at http://www.tomago.com.au.)

In December, the Government of New South Wales announced a feasibility study to build a 500 000-t/y smelter at Lithgow, located approximately 50 km west of Sydney. Australia's Aust-Pac Aluminium, set up by SNC-Lavalin Inc. of Canada, will conduct an A$7 million feasibility study into an A$3.0 billion smelter, which could be in operation by 2001.

Also in December, Comalco Aluminium Ltd. announced that it had selected five bidders for a contract to construct and operate a gas-fired power station in Gladstone, Queensland, to power a proposed new alumina refinery. However, the company said that a final decision had not been made on the location (between Gladstone and Sarawak, Malaysia). Early in 1999, the Government of Australia announced that it would offer Comalco an investment incentive of A$100 million to develop a $3 billion greenfield alumina refinery in Queensland, conditional on an agreement for gas. (For further information on developments in Australia, visit the following web sites: http://www.comalco.com.au/, http://www.isr.gov.au and http://www.riotinto.com.)

RECYCLING

Western World production of secondary aluminum fell to an estimated 7.2 Mt in 1998, compared to 7.4 Mt in 1997. Decreased scrap prices and lower recycling margins likely resulted in this drop. Despite this decrease, there has been a general increase in secondary production over the past few years that can be attributed to continuing improvements in scrap collection systems and increased recycling of consumer products.

The recycling of aluminum requires less than 5% of the energy used to make the original metal. As a result, energy represents only 2% of a secondary aluminum smelter's operating cost, compared to about 26% for a primary smelter. The automotive industry is the largest consumer of secondary aluminum, consuming some 80% of secondary production either through direct sales or to casters that supply the automotive industry. As requirements for lighter vehicles increase, it is likely that demand for secondary aluminum will also increase significantly.

In 1998, the largest secondary aluminum producers were the United States at 3.3 Mt, Japan at 1.2 Mt, and Italy and Germany at 0.5 Mt each. Reported Canadian consumption of secondary aluminum metal (excluding the direct use of scrap) increased to 222 891 t in 1997 from 164 070 t in 1996. (Part of this

increase is due to an increase in the number of companies reporting.)

In Canada, about 1.5 billion scrap aluminum cans are recovered and exported annually to the United States to be recycled. There are no facilities in Canada to recycle aluminum beverage cans. Cans are collected and then shipped to the United States for recycling into can sheet.

Philip Services Corporation sold three of its aluminum recycling plants to Wabash Alloys Inc. The plants included operations in Guelph, Ontario; Syracuse, New York; and Bellwood, Virginia.

PRODUCTION AND CONSUMPTION

World primary aluminum production is estimated to have increased to 22.4 Mt in 1998 from 21.8 Mt in 1997. Aluminum production in 1998 is expected to reach 3.6 Mt in the United States, 3.6 Mt in Western Europe, and 3.0 Mt in Russia.

Total world consumption of primary aluminum is expected to be an estimated 22.1 Mt in 1998, about 1% lower than the revised figure of 22.2 Mt recorded in 1997. Western World demand is expected to have increased by less than 1% to 18.7 Mt in 1998. Total reported Canadian consumption of aluminum metal at the first processing stage, including secondary aluminum, was 781 268 t in 1997, up from 686 969 t in 1996.

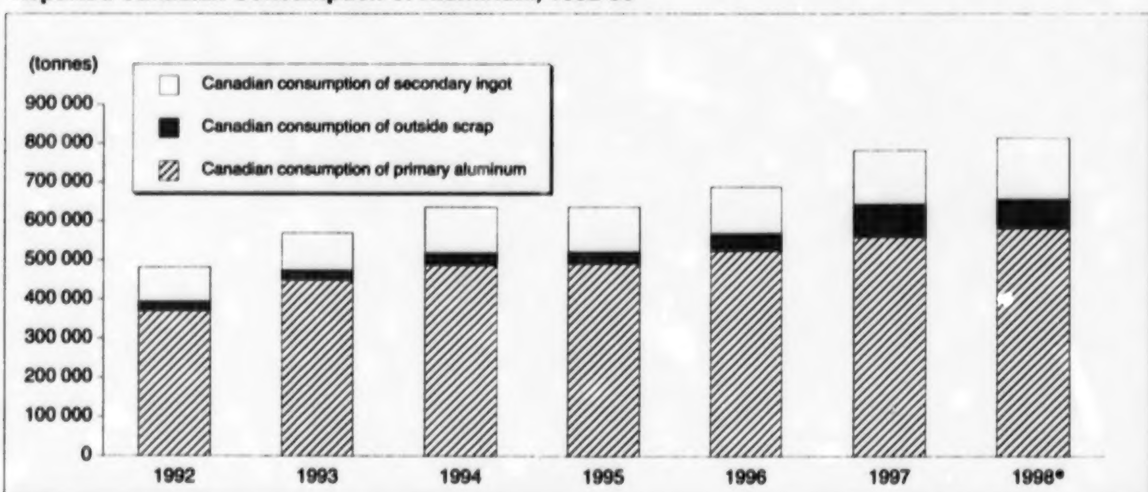
OCCURRENCE, CHARACTERISTICS AND USES

Aluminum is the most abundant metal in the earth's crust (estimated at 8% of the earth's crust). Aluminum does not naturally occur in its native or pure state, but it is found in oxides, hydroxides, halides, sulphates, silicates and as complexes with organic matter.

Both igneous rocks and sedimentary rocks can contain up to 20% aluminum. Aluminum silicates are a major component of soils (contained in clay minerals, sand and rock fragments), glacial tills and the bedrock underlying much of Canada. The aluminum contents of C horizon soils and glacial tills average approximately 8% and range from 3.5% to more than 10%. Aluminum oxide, combined with water and other impurities, is the main ore of aluminum known as bauxite.

Aluminum compounds move through the environment by both anthropogenic (human) activities and natural processes. Natural processes far outweigh the direct anthropogenic redistribution of aluminum in the environment. The chemistry of aluminum in the environment is complex and dependent on many factors. The mobility and subsequent transportation of aluminum ions and compounds are dependent on factors, including the geological weathering environment, chemical speciation (form), soil-water interaction, other elements and compounds present, and composition of the underlying bedrock. The mobiliza-

Figure 2
Reported Canadian Consumption of Aluminum, 1992-98



Source: Natural Resources Canada.
e Estimated.

tion of aluminum in the environment by human activity results predominantly from often distant activities that produce acidic precipitation. In general, a lowering of pH results in the increased mobility of some forms of aluminum.

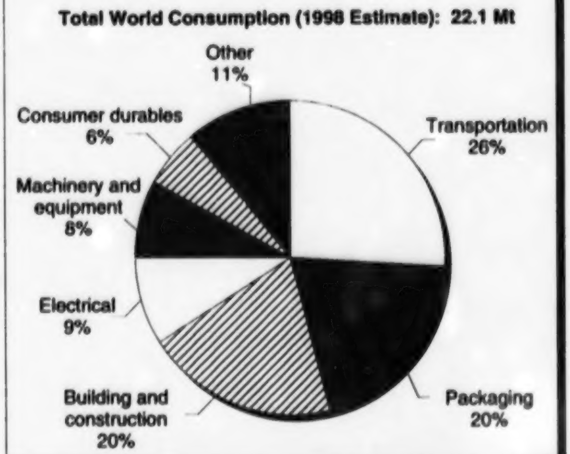
Pure aluminum is a silver-white, malleable, ductile metal with one third the density of steel. Aluminum's dull lustre results from a thin coating of oxide that forms when it is exposed to air. It is this characteristic that accounts for aluminum's resistance to corrosion. Gram for gram, aluminum has twice the electrical conductance of copper. It is also an efficient conductor of heat and a good reflector of light and radiant heat.

Combining aluminum with other metals to produce alloys enhances its characteristics and increases its versatility. The most common metals used in combination with aluminum are copper, magnesium, manganese, silicon and zinc. Aluminum's tensile strength, hardness, corrosion resistance, and heat-treatment properties improve when alloyed with one or more of these metals. Some copper-aluminum alloys, for example, can exceed the tensile strength of mild steel by as much as 50%.

In both its pure and alloyed forms, aluminum is used to make a variety of products for the consumer and capital goods markets. The largest markets for aluminum are transportation (26%), building and construction (20%), packaging (20%), electrical (9%), machinery and equipment (8%), and consumer goods (6%). Geographically, North America is the largest consuming region accounting for 33% of total Western World consumption of aluminum, followed by Europe at 25% and Asia at 26%. The United States is the largest consuming country followed by Japan.

The substitution of aluminum for steel in automobile manufacturing helps reduce weight while maintaining vehicle size. Fuel consumption and, consequently, greenhouse gas emissions are decreased and the lowered weight can also increase safety by reducing stopping distances. Transportation uses are one of the fastest growing areas for aluminum use, growing at a rate of about 4%/y.

Figure 3
Aluminum Markets, 1998



Source: Natural Resources Canada.

PRICES AND STOCKS

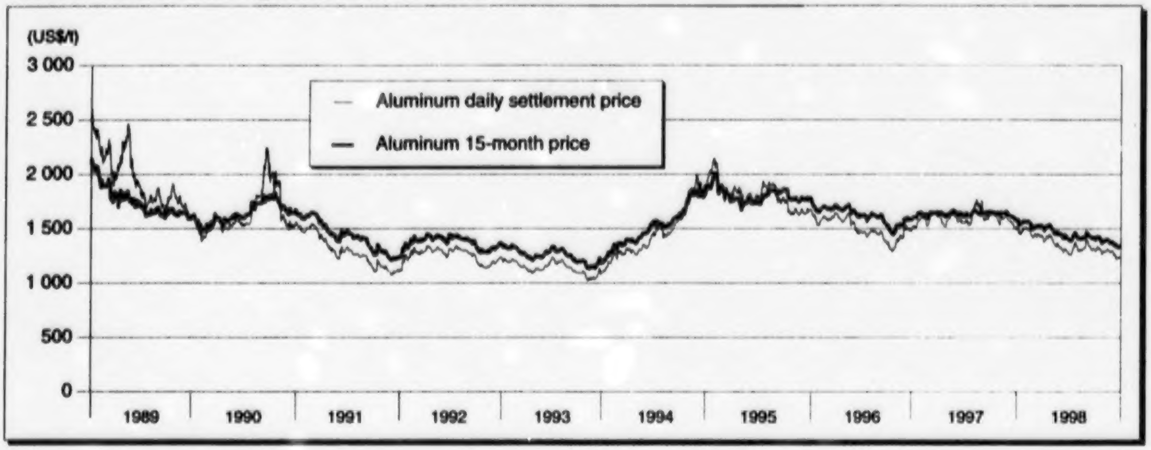
The continuing turmoil in world financial markets put a damper on business confidence in parts of the world throughout the year. This reduced demand, coupled with increased production, continued the downward pressure on prices that started in late 1997. Cash settlement London Metal Exchange (LME) prices started the year at US$1512/t (US69¢/lb), falling throughout the year to a near five-year low of US$1238/t (US56¢/lb) at the end of December, with an average for the year of US$1355/t (US62¢/lb).

The International Primary Aluminium Institute (IPAI) reported that Western World primary aluminum inventories increased to 1.688 Mt at the end of December 1998, compared to 1.636 Mt in December 1997. Total stocks, including all forms of aluminum scrap, primary and secondary ingot, and metal in process, totalled 3.161 Mt at the end of 1998, compared with 3.163 Mt at the end of 1997. Primary stocks on the LME followed a steady decline from about 622 000 t at the start of the year to a minimum of 453 000 t at the end of August before rising to end the year at 636 000 t. Total primary inventories followed the same trend as primary stocks, starting the year at 2.304 Mt, decreasing to 2.070 Mt in July, and then rising to 2.324 Mt at the end of the year.

Prices on the LME for aluminum alloy reflected the general downward trend for primary aluminum. Aluminum alloy settlement prices started 1998 at US$1366/t (US62¢/lb), following a downward trend to end the year at $1028/t (US47¢/lb). For 1998, alloy prices averaged $1203/t (US55¢/lb), compared to an average of US$1463/t (66¢/lb) in 1997. LME aluminum alloy stocks in LME warehouses started the year at around 43 000 t and increased steadily to end the year at approximately 96 000 t.

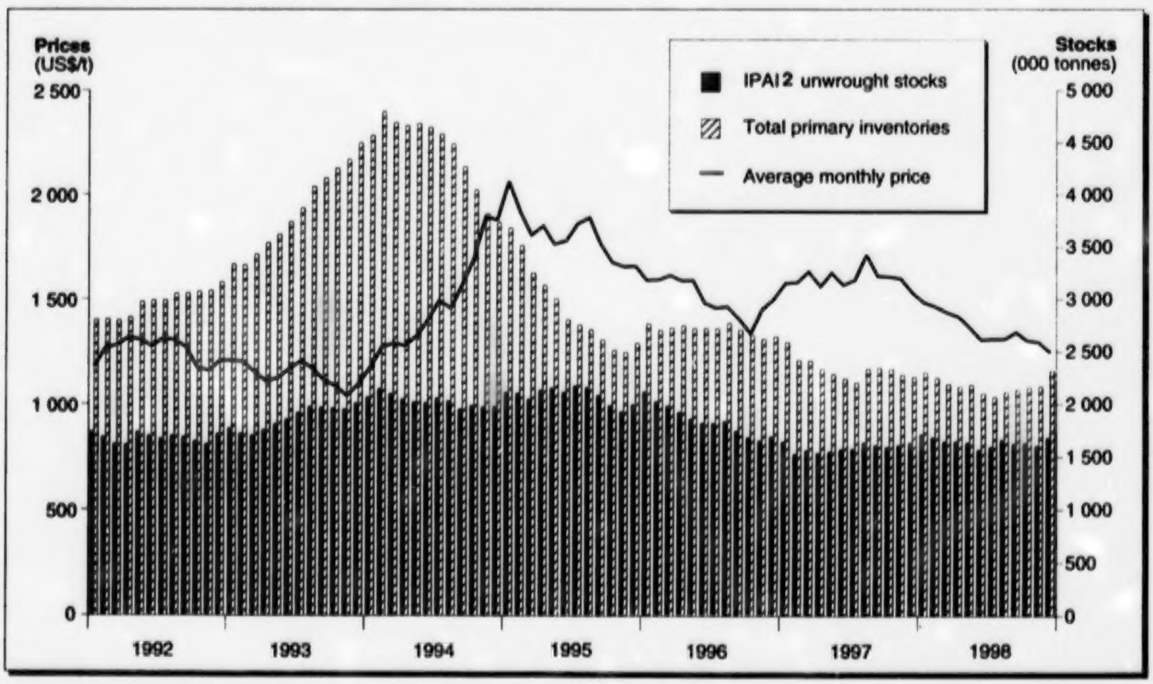
Trading in metallurgical-grade alumina followed the trends set by primary and secondary aluminum prices. Prices for alumina started the year at around US$230/t and declined to US$140$-160/t by year-end. Spot prices for alumina are expected to remain low in 1999 due to the underlying weakness in metal prices and the restarting of idled capacity.

Figure 4
London Metal Exchange Aluminum Prices, 1989-98



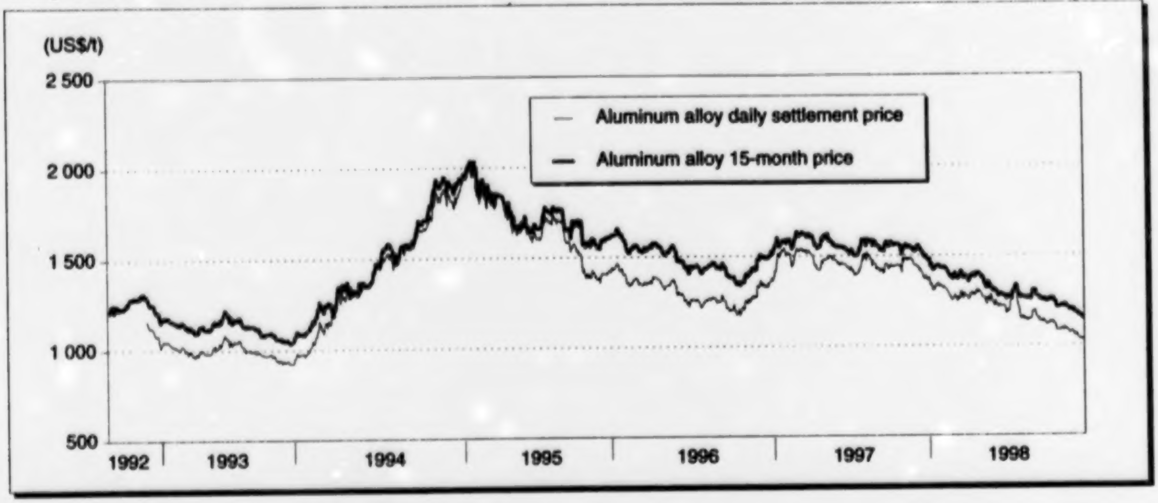
Sources: Natural Resources Canada; London Metal Exchange.

Figure 5
Aluminum Prices and Stocks, 1992-98
LME[1] Settlement Prices and Primary Stocks



Source: Natural Resources Canada.
[1] London Metal Exchange. [2] International Primary Aluminium Institute.

Figure 6
London Metal Exchange Aluminum Alloy Prices, 1992-98
Daily Settlement Prices



Sources: Natural Resources Canada; London Metal Exchange.

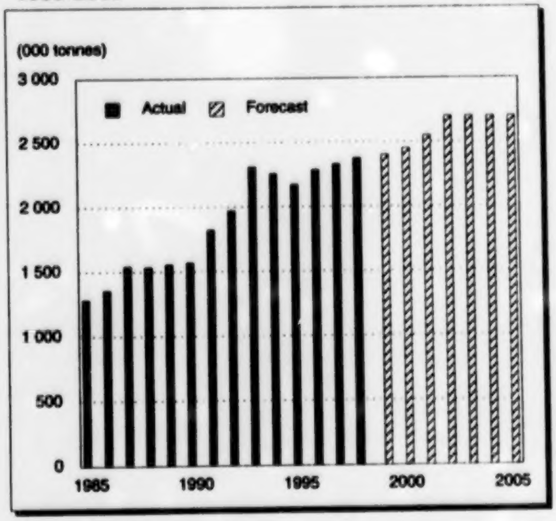
OUTLOOK

Canada is forecast to produce 2.4 Mt of primary aluminum in 1999. Canadian aluminum production capacity increased substantially during the latter half of the 1980s, but is forecast to increase at a slower rate to the year 2005. Apart from Alcan's Alma smelter, no decisions have been made to increase primary production capacity. Work is continuing on proposed projects by Alcan at Kitimat and on a number of other smelter expansion projects in Quebec (at Alouette, Bécancour and Lauralco); however, these latter projects are dependent on new power supply contracts to be negotiated with Hydro-Québec. Canada's reported consumption of primary aluminum in 1999 is expected to remain strong at about 600 000 t.

In 1999, demand for primary aluminum is forecast to be 0.5% higher in the United States, 0.8% lower in Europe, and 3.5% lower in Japan. Total world demand for aluminum is expected to increase by about 1% to 22.2 Mt in 1999. In the longer term, annual growth of 1-3% is forecast for the early part of the next decade. The transportation and packaging markets are expected to lead the increase in demand for aluminum to the year 2005.

IPAI figures show world primary production is expected to rise about 2% to 21.7 Mt in 1999 from 21.3 Mt at the end of 1998, with comparable

Figure 7
Canadian Primary Aluminum Production, 1985-2005



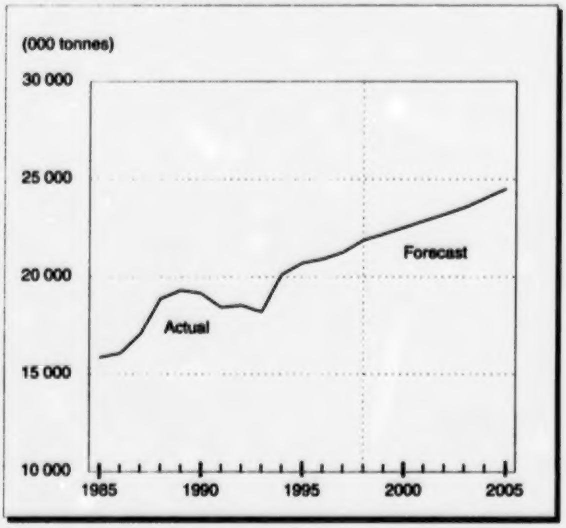
Source: Natural Resources Canada.

increases in the two following years. The increases in Western World capacity expected in 1999 will come primarily from smelter expansions in the United States, Brazil, Argentina, Dubai and Australia.

Current production rates will continue to place downward pressure on prices unless the number of closures of inefficient facilities or those with high debt loads increases. For 1999, prices are forecast to average between US$1000 and $1400/t. In the longer term, prices are expected to average between $1400 and $1850/t (64¢ and 84¢/lb) in constant 1998 dollars.

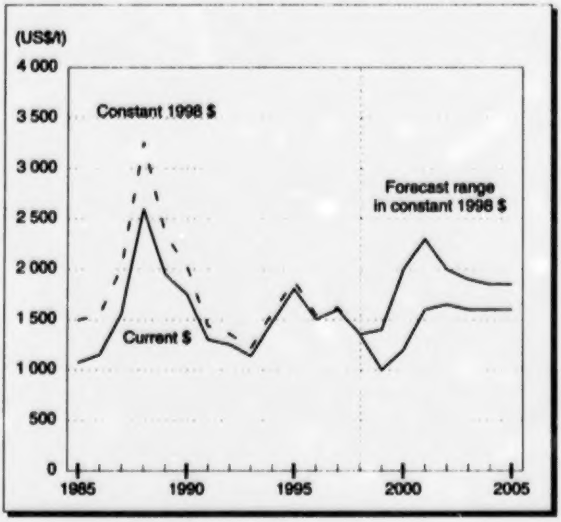
Note: Information in this review was current as of February 20, 1999.

Figure 8
World Aluminum Consumption, 1985-2005



Sources: Natural Resources Canada, World Nonferrous Metal Statistics Group.

Figure 9
LME Daily Official Aluminum Settlement Price, 1985-2005



Source: Natural Resources Canada.

TARIFFS

Item No.	Description	Canada			United States	EU	Japan[1]
		MFN	GPT	USA	Canada	MFN	WTO
2606.00.00	Aluminum ores and concentrates	Free	Free	Free	Free	Free	Free
2818.20.00	Aluminum oxide, other than artificial corundum	Free	Free	Free	Free	4.3%	Free
7601.10	Unwrought aluminum, not alloyed	Free	Free	Free	Free	6%	0.2%
7601.20	Unwrought aluminum alloys	Free	Free	Free	Free	6%	0.2%
7602.00	Aluminum waste and scrap	Free	Free	Free	Free	Free-0.6%	Free
76.03	Aluminum powders and flakes	3.5-5%	Free	Free	Free	5.1-5.3%	3.6%
76.04	Aluminum bars, rods and profiles	Free-5%	Free	Free	Free	8%	8.3-8.6%
76.05	Aluminum wire	Free-4%	Free	Free	Free	8%	8.3-8.6%
76.06	Aluminum plates, sheets and strip, of a thickness exceeding 0.2 mm	Free-6.5%	Free-5%	Free	Free	8%	Free-2.2%
76.07	Aluminum foil not exceeding 0.2 mm	Free-6.5%	Free-5%	Free	Free	8-10%	8.6%
76.08	Aluminum tubes and pipes	Free-5%	Free	Free	Free	Free-8%	8.6%
7609.00	Aluminum tube or pipe fittings	5.5%	3%	Free	Free	7%	3.6%
76.10	Aluminum structures (excluding prefabricated buildings of heading no. 94.06) and parts of structures, aluminum plates, rods, profiles, tubes and the like, prepared for use in structures	6.5%	5%	Free	Free	6.2-7%	1-3.4%
7611.00	Aluminum reservoirs, tanks, vats and similar containers, for any material	Free-6.5%	Free-5%	Free	Free	6.2%	3.6%
76.12	Aluminum casks, drums, cans, boxes and similar containers, for any material	6.5%	2.5-5%	Free	Free	6.2%	3.6%
7613.00	Aluminum containers for compressed or liquefied gas	6.5%	5%	Free	Free	6.2%	3.6%
76.14	Stranded wire, cables, plaited bands and the like, of aluminum, not electrically insulated	4.5%	3%	Free	Free	6.2%	4%
76.15	Table, kitchen or other household articles and parts thereof, of aluminum	6.5%	Free-5%	Free	Free	6.2%	1%
76.16	Other articles of aluminum	Free-6.5%	Free-5%	Free	Free	6.2%	3.4%

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999; Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of the European Union (38th Annual Edition: 1998); Custom Tariff Schedules of Japan, 1998.

[1] WTO rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADA, ALUMINUM PRODUCTION AND TRADE, 1997 AND 1998

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
PRODUCTION		2 327 188	. .	2 374 118	. .
IMPORTS					
2606.00	Aluminum ores and concentrates				
	Australia	641 062	19 024	1 117 883	63 967
	Brazil	1 374 412	48 091	1 584 427	59 733
	Guinea	762 080	25 749	772 361	26 673
	Guyana	217 638	7 092	310 215	11 097
	United States	62 570	5 239	74 754	6 048
	China	49 710	4 141	29 004	2 857
	Other countries	55 349	1 610	68	5
	Total	3 162 821	110 946	3 888 712	170 380
2620.40	Ash and residues containing mainly aluminum	1 774	1 381	4 520	4 333
2818.20	Aluminum oxide (excluding artificial corundum)				
	Australia	1 521 664	372 870	1 379 872	373 646
	United States	912 661	279 782	1 046 902	337 419
	Jamaica	768 695	220 168	721 190	197 967
	Brazil	28	44	21 048	6 259
	China	4 876	1 059	7 271	3 962
	Austria	2 715	3 068	1 631	3 136
	Other countries	50 229	17 659	5 347	6 305
	Total	3 260 868	894 650	3 183 261	928 694
2818.30	Aluminum hydroxide	14 895	8 195	15 604	9 413
7601.10	Unwrought aluminum, not alloyed				
	United States	19 958	52 961	30 670	71 241
	Tajikistan	288	480	788	1 366
	Russia	691	1 507	1 052	340
	Other countries	321	589	129	318
	Total	21 258	55 537	32 639	73 265
7601.20	Unwrought aluminum, alloyed				
	United States	147 466	290 056	149 544	306 341
	Russia	4 601	8 995	12 649	26 014
	United Kingdom	803	2 022	2 452	5 178
	Tajikistan	120	211	2 304	4 605
	Netherlands	2 138	4 862	723	1 453
	Other countries	631	1 753	1 360	3 454
	Total	155 759	307 899	169 032	347 045
7602.00	Aluminum waste and scrap	92 600	138 877	107 425	151 770
76.03	Aluminum powders and flakes	2 065	8 103	2 151	8 804
76.04	Aluminum bars, rods and profiles				
7604.10	Of aluminum, not alloyed				
	United States	7 737	29 907	8 593	33 301
	Belgium	566	3 054	560	3 116
	Austria	1	6	577	1 570
	Other countries	712	2 701	387	1 724
	Total	9 016	35 668	10 117	39 711
7604.21 to 7604.29	Of aluminum alloys				
	United States	23 995	126 768	29 598	153 352
	Sweden	448	4 118	180	1 836
	France	212	1 120	383	1 835
	China	45	186	262	1 063
	Other countries	821	5 049	958	5 461
	Total	25 521	137 241	31 381	163 547
76.05	Aluminum wire	4 585	22 138	5 582	26 142
76.06	Aluminum plates, sheets and strip, of a thickness exceeding 0.2 mm	376 680	1 315 831	402 612	1 446 029

TABLE 1 (cont'd)

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)					
76.07	Aluminum foil not exceeding 0.2 mm	41 105	176 788	38 257	174 294
76.08	Aluminum tubes and pipes	8 660	42 308	9 592	48 781
76.09	Aluminum tube or pipe fittings	. .	27 393	. .	29 038
		(number 000)		**(number 000)**	
76.10	Aluminum structures and parts of structures, aluminum plates, rods, profiles, tubes and the like, prepared for use in structures	. .	66 590	. .	76 859
76.11	Aluminum reservoirs, tanks, vats and similar containers, for any material	. . .	1 142	1	8 073
76.12	Aluminum casks, drums, cans, boxes and similar containers, for any material	879 164	134 369	1 343 082	214 720
76.13	Aluminum containers for compressed or liquefied gas	122	14 379	108	16 594
		(tonnes)		**(tonnes)**	
76.14	Stranded wire, cables, plaited bands and the like, of aluminum, not electrically insulated	1 422	4 239	317	1 110
76.15	Table, kitchen or other household articles and parts thereof, of aluminum	. .	84 479	. .	85 736
76.16	Other articles of aluminum	. .	202 352	. .	236 629
EXPORTS					
2606.00	Aluminum ores and concentrates				
	United States	372	53	47	4
	Switzerland	184	71	–	–
	Total	556	124	47	4
2620.40	Ash and residues containing mainly aluminum	13 020	8 369	11 314	8 087
2818.20	Aluminum oxide (excluding artificial corundum)				
	United States	59 506	47 991	58 217	47 052
	Saudi Arabia	34	57	84	139
	Belgium	312	203	41	78
	Other countries	1 180	1 572	51	63
	Total	61 032	49 823	58 393	47 332
7601.10	Unwrought aluminum, not alloyed				
	United States	627 010	1 464 171	611 498	1 362 741
	Netherlands	165 893	342 711	174 126	368 711
	Japan	34 187	69 414	39 693	78 131
	South Korea	25 367	61 445	22 519	49 323
	United Kingdom	19 742	36 209	16 200	31 568
	Other countries	18 325	42 743	6 324	14 817
	Total	890 524	2 016 693	870 360	1 905 291
7601.20	Unwrought aluminum alloys				
	United States	783 337	1 974 439	825 139	2 027 645
	Japan	127 384	285 085	117 118	243 890
	South Korea	35 540	87 447	17 790	41 914
	United Kingdom	4 366	11 942	4 727	12 769
	Italy	8 393	19 338	4 107	9 833
	Netherlands	9 487	23 047	3 453	8 305
	Israel	11 394	30 645	2 819	7 126
	Lebanon	3 921	10 714	2 004	5 320
	Ireland	3 598	10 595	1 995	5 319
	Other countries	8 091	21 498	6 794	17 547
	Total	995 511	2 474 750	985 948	2 379 668

TABLE 1 (cont'd)

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
7602.00	Aluminum waste and scrap				
	United States	242 554	436 391	258 645	439 526
	Japan	9 973	24 029	8 367	18 822
	Netherlands	5 066	12 064	6 842	15 795
	China	948	1 088	1 980	2 438
	Other countries	12 716	20 142	5 342	7 973
	Total	271 257	493 714	281 176	484 554
76.03	Aluminum powders and flakes	1 475	3 368	1 359	3 612
76.04	Aluminum bars, rods and profiles	63 973	281 731	75 545	350 508
76.05	Aluminum wire	81 951	226 744	82 978	220 316
76.06	Aluminum plates, sheets and strip, of a thickness exceeding 0.2 mm	261 649	813 850	290 465	896 800
76.07	Aluminum foil not exceeding 0.2 mm	30 210	149 853	32 862	142 778
76.08	Aluminum tubes and pipes	5 669	28 747	6 110	30 890
76.09	Aluminum tube or pipe fittings	. .	12 390	. .	12 502
76.10	Aluminum structures and parts of structures, aluminum plates, rods, profiles, tubes and the like, prepared for use in structures	. .	136 767	. .	182 349
		(number 000)		(number 000)	
7611.00	Aluminum reservoirs, tanks, vats and similar containers, for any material	2	1 006	1	802
76.12	Aluminum casks, drums, cans, boxes and similar containers, for any material	609 734	89 492	335 177	79 504
7613.00	Aluminum containers for compressed or liquefied gas	1 541	3 815	870	5 182
		(tonnes)		(tonnes)	
76.14	Stranded wire, cables, plaited bands and the like, of aluminum, not electrically insulated	8 541	20 789	7 920	27 896
76.15	Table, kitchen or other household articles and parts thereof, of aluminum	. .	56 751	. .	56 447
76.16	Other articles of aluminum	. .	129 159	. .	163 315

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available or not applicable; . . . Amount too small to be expressed; p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, ALUMINUM SMELTER CAPACITY

Company	As of December 31, 1998
	(tonnes/year)
Alcan Aluminium Limited	
Quebec	
Grande-Baie	180 000
Arvida, Jonquière	232 000
Isle-Maligne, Alma	73 000
Shawinigan	84 000
Beauharnois	48 000
Laterrière	204 000
British Columbia	
Kitimat	272 000
Total Alcan capacity	1 093 000
Canadian Reynolds Metals Company, Limited	
Quebec	
Baie-Comeau	400 000
Aluminerie de Bécancour Inc.	
Quebec	
Bécancour	372 000
Aluminerie Alouette Inc.	
Quebec	
Sept-Îles	230 000
Alcoa Aluminerie Lauralco Inc.	
Quebec	
Deschambault	225 000
Total Canadian capacity	2 320 000

Source: Natural Resources Canada.

TABLE 3. CANADA, CONSUMPTION[1] OF ALUMINUM METAL[4] AT FIRST PROCESSING STAGE, 1995-97

	1995	1996[a]	1997[a]
		(tonnes)	
CASTINGS			
Permanent mould	80 943[r]	86 766[r]	92 288[r]
Sand	2 663	2 742[r]	3 351[r]
Die and other	100 671[r]	120 793	150 829[r]
Total	184 277[r]	210 301	246 469[r]
WROUGHT PRODUCTS			
Sheet, plate, coil and foil	164 221	191 754	180 745
Extrusions, including tubing	110 084	111 363	149 958[r]
Other wrought products (including rods, forgings and slugs)	138 836	139 245	165 039[r]
Total	413 141	442 362	495 742[r]
OTHER USES			
Destructive uses (deoxidizer), non-aluminum base alloys, powder and paste and other uses	37 984	34 306	39 057[r]
Total consumed	635 402[r]	686 969	781 268[r]
Aluminum metal used for the production of secondary aluminum ingot[2]	146 987	138 762	128 515[r]

	Metal Entering Plant			On Hand at December 31		
	1995	1996	1997	1995	1996	1997
Primary aluminum ingot and alloys	526 205	560 146[r]	572 606[r]	16 986	16 434[r]	16 892[r]
Secondary aluminum	113 607	120 561[r]	138 771[r]	4 351	5 198[r]	5 315[r]
Scrap originating outside plant	162 275[r]	146 198	199 926[r]	5 763[r]	3 958[r]	6 902[r]
Total	802 087[r]	826 905[r]	911 302[r]	27 101[r]	25 590[r]	29 109[r]
Aluminum shipments[3]				25 804	2 829	1 696

Source: Natural Resources Canada.
[r] Revised.
[a] Increase in number of companies being surveyed; therefore, the closing inventory of the previous year does not equal the opening inventory of the current year.
[1] Available data as reported by consumers. [2] Aluminum metal used in the production of secondary aluminum is not included in consumption totals. [3] Aluminum metal shipped without change. Does not refer to shipments of goods of own manufacture. [4] Aluminum metal refers to primary aluminum ingot and alloys, purchased secondary aluminum ingot, and outside aluminum scrap.
Note: Numbers may not add to totals due to rounding.

TABLE 4. AVERAGE ALUMINUM PRICES

Year	Month	LME Cash[1]	*Metals Week* U.S. Markets[1]
		(US$/t)	(US¢/lb)
ANNUAL AVERAGES[2]			
1987		1 560.90	72.3
1988		2 597.80	110.1
1989		1 951.50	87.8
1990		1 751.80	75.0
1991		1 302.70	59.5
1992		1 254.60	57.5
1993		1 139.40	53.3
1994		1 477.20	71.2
1995		1 806.10	85.9
1996		1 506.00	71.3
1997		1 599.70	77.1
1998		1 357.80	65.6
MONTHLY AVERAGES			
1997	January	1 576.05	76.1
	February	1 580.43	76.4
	March	1 623.71	79.6
	April	1 561.77	75.6
	May	1 625.65	78.7
	June	1 567.90	75.5
	July	1 592.37	76.3
	August	1 711.18	80.1
	September	1 611.00	77.0
	October	1 608.30	76.7
	November	1 599.38	78.1
	December	1 530.93	74.8
1998	January	1 486.10	71.9
	February	1 465.95	70.4
	March	1 438.02	69.2
	April	1 418.60	68.8
	May	1 365.13	66.0
	June	1 307.59	63.4
	July	1 309.57	63.5
	August	1 311.25	63.3
	September	1 342.66	65.5
	October	1 304.41	62.9
	November	1 295.29	61.9
	December	1 249.41	60.1

Sources: Natural Resources Canada; *Metals Week.*
[1] Highest grade sold. [2] Primary ingots, minimum 99.7% purity; prior to October 1988, minimum 99.5% purity.

TABLE 5. AVERAGE ALUMINUM ALLOY (SECONDARY) PRICES

Year	Month	LME Alloy[1] Cash
		(US$/t)
ANNUAL AVERAGES		
1993		1 005.2
1994		1 452.9
1995		1 656.0
1996		1 302.8
1997		1 461.0
1998		1 203.8
MONTHLY AVERAGES		
1997	January	1 491.3
	February	1 497.2
	March	1 523.1
	April	1 454.2
	May	1 481.7
	June	1 447.4
	July	1 425.3
	August	1 475.9
	September	1 426.6
	October	1 442.6
	November	1 470.3
	December	1 396.4
1998	January	1 329.6
	February	1 291.0
	March	1 270.6
	April	1 284.3
	May	1 263.7
	June	1 223.8
	July	1 241.8
	August	1 147.5
	September	1 152.3
	October	1 112.2
	November	1 083.1
	December	1 045.3

Source: *Metals Week.*
1 Alloy ingots meeting LME specifications.

TABLE 6. WORLD MINE PRODUCTION OF BAUXITE, 1994-97

	World Rank in 1997	1994	1995	1996	1997p
			(000 tonnes)		
Australia	1	41 646.0	42 655.0	43 063.0	44 465.0
Brazil	4	8 673.3	10 214.1	11 060.1	11 503.8
China	5	6 621.3	8 255.5	8 878.8	9 000.0
France	20	128.0	131.0	165.0	100.0
Ghana	15	426.1	513.0	473.2	519.2
Greece	12	2 196.4	2 200.2	2 230.0	1 875.9
Guinea	2	14 833.4	17 733.3	18 492.6	19 250.0
Guyana	11	1 911.1	2 028.1	2 475.5	2 467.3
Hungary	14	835.7	1 014.6	1 055.8	742.6
India	6	4 809.1	5 240.0	5 757.5	5 800.3
Indonesia	13	1 342.4	899.0	842.0	808.7
Iran•	21	100.0	100.0	100.0	100.0
Italy		23.4	11.2	–	–
Jamaica	3	11 563.5	10 857.5	11 862.7	11 983.1
Kazakstan	10	2 584.0	3 318.5	3 346.0	3 400.0
Malaysia	18	161.9	184.4	218.7	279.0
Mozambique	24	9.6	11.2	11.5	8.2
Pakistan	25	4.6	3.1	4.1	3.0
Romania	19	184.1	175.0	175.2	127.5
Russia	8	3 633.0	3 706.0	3 928.0	3 991.0
Serbia and Montenegro	16	1.3	60.0	323.0	470.0
Sierra Leone	23	734.7	0.0	32.8	99.6
Suriname	9	3 803.1	3 596.3	3 695.3	3 877.2
Turkey	17	445.0	232.3	544.5	412.8
United States	22	100.0	100.0	100.0	100.0
Venezuela	7	4 419.2	5 022.0	4 806.9	5 083.9
Total world		111 190.2	118 261.3	123 642.2	126 468.1

Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics.
– Nil; • Estimated; p Preliminary.

TABLE 7. WORLD PRODUCTION OF ALUMINA (HYDRATE), 1994-97

	World Rank in 1997	1994	1995	1996	1997p
			(000 tonnes)		
Australia	1	12 792.0	13 147.0	13 349.0	13 385.0
Azerbaijan	27	70.0	27.0	–	80.0
Bosnia	29	–	25.0	25.0	–
Brazil	4	1 867.5	2 142.9	2 759.0	3 088.0
Canada[1]	11	1 170.0	1 064.0	1 060.0	1 165.0
China	5	1 846.9	2 222.7	2 616.0	3 063.4
France	19	438.0	525.0	542.0	589.0
Germany[1]	16	950.7	994.0	792.0	850.0
Greece	18	607.5	629.7	619.8	615.7
Guinea	20	648.4	630.4	622.0	527.0
Hungary	24	243.4	353.5	358.7	111.1
India	7	1 455.8	1 672.0	1 706.0	1 940.0
Ireland	10	1 140.0	1 186.0	1 234.0	1 300.0
Italy	15	852.1	857.0	881.0	914.0
Jamaica	3	3 221.2	3 030.2	3 200.0	3 414.0
Japan	17	674.6	743.2	718.9	720.0
Kazakstan	13	822.0	1 022.0	1 083.4	1 094.2
Romania[1]	21	301.6	322.8	258.5	280.0
Russia	6	2 168.4	2 254.0	2 148.0	2 379.8
Serbia and Montenegro	23	60.6	35.3	105.0	160.0
Slovakia	28	90.0	65.0	56.0	46.8
South Korea	26	–	–	100.0	100.0
Spain	12	1 070.6	1 094.8	1 094.8	1 110.3
Suriname	9	1 498.1	1 588.8	1 600.0	1 600.0
Turkey	22	155.3	172.0	159.3	164.3
Ukraine	14	1 081.0	1 198.0	1 161.0	1 074.5
United Kingdom	25	110.0	108.0	99.0	100.0
United States[1]	2	4 860.0	4 533.0	4 700.0	5 093.0
Venezuela	8	1 551.5	1742.0	1 775.0	1 775.0
Total world		41 747.2	43 385.3	44 822.9	46 740.1

Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics.
– Nil; p Preliminary.
[1] Calcined.

TABLE 8. WORLD PRODUCTION OF ALUMINUM, 1994-97

	World Rank in 1997	1994	1995	1996p	1997e
			(000 tonnes)		
Argentina	22	175.0	185.5	183.9	183.7
Australia	5	1 310.8	1 292.6	1 370.3	1 490.1
Azerbaijan	46	10.0	11.0	0.0	0.0
Bahrain	12	451.9	453.9	464.5	489.9
Bosnia	42	–	–	–	4.0
Brazil	6	1 184.6	1 188.1	1 197.4	1 189.1
Cameroon	32	81.1	79.3	82.3	90.9
Canada	3	2 254.7	2 172.0	2 283.2	2 327.2
China	4	1 462.2	1 676.1	1 770.9	2 046.3
Egypt	23	181.5	180.3	179.2	178.2
France	13	384.1	364.5	380.1	399.4
Germany	10	505.0	575.2	576.5	571.9
Ghana	25	140.7	135.4	137.0	151.6
Greece	26	138.0	130.9	130.9	132.6
Hungary	38	30.7	34.9	33.5	32.5
Iceland	27	98.6	100.2	103.4	122.9
India	11	472.0	536.5	530.6	547.4
Indonesia	19	221.9	228.1	223.1	222.7
Iran	31	116.0	117.0	80.1	92.3
Italy	21	175.6	177.8	184.4	187.7
Japan	41	17.0	18.0	17.0	16.7
Mexico	35	0.0	10.4	61.5	66.4
Netherlands	18	219.4	215.6	227.0	231.8
New Zealand	16	268.0	273.3	284.5	310.3
Nigeria	43	0.0	0.0	0.0	2.0
Norway	7	858.2	846.7	862.3	918.6
Poland	37	49.5	55.7	51.9	51.6
Romania	24	119.6	140.5	140.9	154.0
Russia	2	2 670.5	2 790.0	2 874.2	2 906.0
Serbia and Montenegro	33	10.6	26.0	51.1	80.6
Slovakia	28	33.0	59.0	111.5	110.1
Slovenia	34	74.3	70.2	65.8	74.4
South Africa	8	172.7	233.3	617.0	682.9
South Korea	44	0.0	0.0	0.0	0.0
Spain	15	338.1	361.9	361.8	359.9
Suriname	40	26.7	28.1	26.0	23.1
Sweden	30	83.9	94.5	98.3	98.4
Switzerland	39	24.2	20.7	26.6	27.3
Tajikistan	20	236.5	237.0	198.3	188.9
Taiwan	45	0.0	0.0	0.0	0.0
Turkey	36	59.7	61.5	62.1	62.0
Ukraine	29	102.0	95.1	90.7	100.5
United Arab Emirates	14	246.9	247.4	258.5	377.7
United Kingdom	17	231.2	237.9	240.0	247.7
United States	1	3 298.5	3 375.1	3 577.2	3 603.4
Venezuela	9	585.4	627.9	634.9	640.8
Total World		19 120.3	19 765.1	20 850.4	21 795.5

Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics.
– Nil; e Estimated; p Preliminary.

TABLE 9. WORLD CONSUMPTION OF ALUMINUM, 1995-98

	World Rank in 1997	1995r	1996r	1997p	1998e
			(000 tonnes)		
Albania•	72	1.0	1.0	1.0	1.0
Algeria	66	5.0	5.0	5.0	5.0
Argentina	32	84.0	86.4	95.3	98.0
Australia	15	351.8	324.4	362.1	330.0
Austria	25	150.0	155.0	162.0	152.0
Bahrain	28	135.0	137.0	137.0	137.0
Bangladesh•	61	10.0	10.0	10.0	10.0
Belgium/Luxembourg	14	340.0	331.0	345.0	382.2
Brazil	10	499.8	497.0	478.6	545.0
Bulgaria	62	6.0	6.7	7.0	8.0
Cameroon	50	21.0	18.0	24.7	24.7
Canada	8	611.9	619.9	642.4	650.0
Chile•	57	15.0	13.9	15.5	15.0
China•	2	1 874.9	2 033.1	2 087.0	2 245.7
Colombia	58	33.3	18.0	16.0	15.0
Croatia	51	24.4	20.7	12.9	21.0
Cuba	73	1.0	1.0	1.0	1.0
Czech Republic	40	58.9	53.0	55.0	53.2
Denmark	52	27.6	27.0	36.0	20.0
Egypt	33	77.4	79.2	97.9	95.0
Finland	45	31.0	30.4	33.1	40.0
France	6	743.8	671.7	723.6	700.0
Germany	4	1 510.0	1 355.0	1 567.4	1 860.0
Ghana	55	16.1	16.1	16.0	16.0
Greece	26	162.8	156.4	203.8	150.0
Hong Kong	18	116.6	149.4	226.8	196.0
Hungary	22	120.6	158.6	171.5	171.5
Iceland	70	1.0	1.0	1.7	1.7
India	9	581.0	584.8	585.0	560.0
Indonesia•	38	147.7	161.3	206.0	60.0
Iran•	30	120.0	120.0	120.0	120.0
Iraq•	74	1.0	1.0	1.0	0.0
Ireland	64	3.3	3.8	5.8	5.0
Israel	43	43.1	45.0	45.0	45.0
Italy	5	631.0	614.0	671.0	760.0
Japan	3	2 336.4	2 392.6	2 434.3	2 140.0
Lebanon	60	7.0	10.0	12.0	12.0
Macedonia	67	2.0	2.8	2.0	4.0
Malaysia	37	114.0	140.0	102.4	62.5
Mexico	34	40.0	92.7	83.2	87.0
Morocco	69	2.0	1.6	2.0	2.0
Netherlands	24	150.0	145.0	155.0	155.0
New Zealand	47	38.6	38.9	37.0	37.0
Nigeria	63	7.0	7.0	7.0	7.0
North Korea	46	20.0	20.0	40.0	40.0
Norway	17	157.0	169.0	197.0	200.0
Other Europe	65	0.0	0.0	2.0	5.0
Pakistan	56	13.0	15.0	15.0	15.0
Peru•	68	4.5	3.6	4.0	4.0
Philippines	48	31.4	26.3	34.2	27.0
Poland	31	88.4	88.3	101.5	110.0
Portugal	35	66.7	58.1	75.4	85.0
Romania	39	34.3	37.3	48.0	56.0
Russia	11	476.0	444.1	508.7	510.0
Saudi Arabia	41	30.0	47.1	48.0	48.0

TABLE 9 (cont'd)

	World Rank in 1997	1995r	1996r	1997p	1998e
			(000 tonnes)		
Serbia and Montenegro	53	9.0	17.3	23.7	20.0
Singapore	54	39.2	40.0	40.0	19.0
Slovakia	49	25.0	25.0	25.0	25.0
Slovenia	36	56.9	49.5	61.3	74.0
South Africa	29	119.7	101.6	126.0	130.0
South Korea	12	675.3	674.3	666.3	400.9
Spain	13	350.0	360.0	410.0	400.0
Sweden	20	116.0	129.0	142.0	180.0
Switzerland	23	143.3	140.2	164.0	170.0
Taiwan	16	362.5	310.3	374.3	320.0
Thailand	21	253.5	220.2	232.8	175.0
Tunisia	71	3.3	3.5	1.0	1.0
Turkey	27	144.0	136.0	144.0	144.0
United States	1	5 300.0	5 500.0	5 800.0	5 875.0
United Arab Emirates	44	50.1	51.0	60.0	44.0
United Kingdom	42	24.6	30.0	30.0	48.0
Venezuela	7	620.0	600.0	620.0	660.0
Vietnam e	19	183.0	206.9	193.4	190.0
Other	59	13.9	15.0	15.0	15.0
Total world		20 714.3	20 911.9	22 263.6	22 051.4

Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics.
e Estimated; p Preliminary; r Revised.

TABLE 10. WESTERN WORLD PRODUCTION OF SECONDARY ALUMINUM, 1993-98

	1993	1994	1995	1996	1997p	1998e
			(000 tonnes)			
Africa	32.0	32.0	37.5	37.0	37.2	31.0
Argentina	14.4	14.4	10.0	15.8	15.8	16.0
Australia	34.8	55.0	37.7	57.1	53.8	57.2
Austria	43.3	52.5	93.5	97.5	116.5	116.5
Brazil	76.8	91.0	116.7	145.6	163.4	163.4
Canada	90.0	95.0	97.0	101.0	100.0	100.0
Croatia	28.1	29.9	33.6	38.2	21.2	18.3
Denmark	14.0	14.0	14.0	14.0	14.0	14.0
Finland	29.9	31.0	33.5	33.6	38.2	34.2
France	222.4	253.4	253.6	236.8	241.7	241.5
Germany	408.1	438.1	418.8	416.9	432.5	453.3
Iran	15.1	26.0	26.0	26.0	26.0	26.0
Italy	346.1	355.8	396.6	376.6	442.9	530.0
Japan	1 005.6	1 173.5	1 180.5	1 191.8	1 278.3	1 154.7
Mexico	40.7	145.2	128.6	85.0	123.2	135.6
Netherlands	139.1	150.0	191.5	150.0	150.4	150.4
New Zealand	7.3	8.2	8.0	8.0	8.0	8.0
Norway	55.8	49.2	71.9	59.7	58.6	62.4
Portugal	2.0	3.0	3.0	3.0	3.0	3.2
Spain	99.7	103.5	107.0	153.8	153.8	154.0
Sweden	19.0	21.5	23.0	24.5	25.0	25.0
Switzerland	4.2	6.2	5.3	6.0	7.9	7.9
Taiwan	64.0	64.0	67.0	67.0	67.0	67.0
United States	2 994.9	2 958.8	3 188.0	3 205.5	3 543.4	3 333.8
United Kingdom	236.2	224.3	229.7	257.2	236.6	236.6
Venezuela	34.8	31.9	27.5	21.4	21.4	21.4
Yugoslavia	n.a.	n.a.	n.a.	5.0	5.2	5.2
Total	6 058.3	6 427.4	6 799.5	6 834.0	7 385.0	7 166.6

Source: World Bureau of Metal Statistics.
e Estimated; n.a. Not applicable.

Cement

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Shipments of cement in 1998 were estimated to be 12.1 Mt valued at $1.13 billion, based on preliminary data. This compares to shipments of 11.7 Mt valued at $1.06 billion in 1997, based on final data. Demand for cement in Ontario remained relatively strong; however, in British Columbia, there was a substantial decrease in demand, according to the Portland Cement Association. Overall construction activity in Canada was weaker, affected mainly by an 8% drop in residential construction. The extended $6 billion cost-shared program for infrastructure renewal contributed to total activity, although new funding for the existing program expired in 1998.

Canadian Industry

The Canadian cement industry is diversified and mainly integrated with the construction aggregates and concrete products sectors. Information on the aggregates sector is included in a separate chapter entitled *Mineral Aggregates*.

Clinker-producing and finish-grinding capacities of cement plants, on a company-by-company basis, are listed in Table 2. Reported kiln capacity in 1997 was about 14.2 Mt with about 13.1 Mt active, according to the most recent figures available. Clinker production is more indicative of ultimate cement production capacity because clinker can be stockpiled for later use or sale. The overall output of the cement industry is best represented by total cement shipments plus clinker exports, as shown in Table 3. The average kiln capacity has increased from about 300 000 t/y in 1980 to 470 000 t/y in 1997; the average kiln age based on clinker capacity is reported to be about 20 years, according to the Portland Cement Association.

In Atlantic Canada, two cement plants obtain raw materials from on site or nearby. These plants account for about 4% of Canada's total clinker-producing capacity. Nova Scotia and Newfoundland are the only producers of cement in the region.

In Quebec, four clinker-producing plants account for about 21% of Canada's output. St. Lawrence Cement Inc. (SLC) is the dominant manufacturer of cement and a leading producer of concrete and aggregates in eastern Canada. Its major markets, in competition with Lafarge Canada Inc. and Ciment Québec Inc., are in Quebec, the Maritime provinces and the northeastern United States. Considering the northeastern region of North America as a whole, there are generally four to six distribution terminals for each cement clinker plant.

In Ontario, clinker-producing plants account for about 48% of Canadian capacity. SLC, Blue Circle Canada Inc. and Lafarge Canada Inc. are the largest producers. Lafarge's raw materials handling is extensive; for example, limestone for its plant at Bath is quarried on site and silica is supplied from Potsdam sandstone in Pittsburgh Township, about 50 km east of Bath. Iron oxide and gypsum are purchased from Hamilton and Nova Scotia, respectively. Lafarge's Woodstock plant obtains limestone on site and other raw materials mainly from sources in southern Ontario.

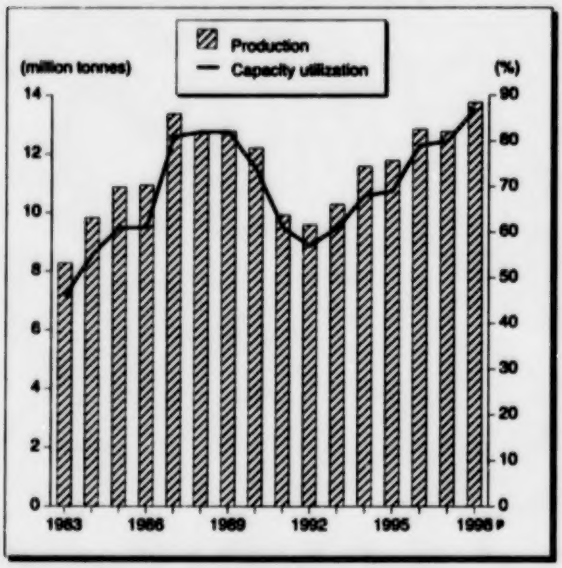
SLC, controlled by Holderbank Financière Glaris of Switzerland, completed an expansion at its Mississauga plant in 1998. (Also, SLC announced plans to build a 2-Mt/y cement plant near Greenport, New York.) In addition to plans to expand its North American cement capacity, SLC plans to produce slag granules from by-products of steel production at Sault Ste. Marie, Ontario, and in the Philadelphia-Camden area in the United States. (The capacity of the Ontario slag granules plant is expected to be about 450 000 t/y.)

ESSROC Canada Inc., part of the Italcementi Group of Companies, announced plans to increase cement production capacity at its Picton, Ontario, plant. These plans are part of a three-year investment plan by the company to increase the capacity of its North American cement plants by 500 000 t.

In western Canada, two companies, CBR/Heidelberger and Lafarge Canada Inc., operate two clinker-producing plants in the Prairie provinces and three in British Columbia. Western Canada accounts for about 27% of the country's clinker-producing capacity, roughly in proportion to its share of total Canadian consumption. Lafarge Canada Inc. continued construction of its new $140 million cement plant on site at its Richmond, British Columbia, operation. Overall capital costs will be lower than a "greenfield" development because existing sites and substantial equipment and infrastructure are already in place.

CBR/Heidelberger affiliate Inland Cement Limited continues to ship cement from its relatively large Edmonton operation to Regina and Winnipeg for wide distribution.

Figure 1
Canadian Cement Production, 1983-98



Sources: Statistics Canada; Portland Cement Association.
pPreliminary.
Note: Cement production includes clinker exports.

World Developments

Multinational companies with widespread production and distribution networks continued to become more dominant in world cement markets. Despite a recession, expansions continued, even in Asia. Exports of cement from China have increased, including first-time shipments to the United States.

World cement production in 1997 was 1515 Mt, according to estimates by the U.S. Geological Survey. China is the world's largest producer (493 Mt), followed by Japan (92 Mt) and the United States (84 Mt).

In the United States, Florida Rock Industries continued work on its new 700 000-t/y plant in Florida.

The U.S. antidumping order against grey Portland cement clinker from Mexico remained in effect in 1997. In accordance with earlier rulings, Cemex (Cementos Mexicanos, S.A.), which is the largest cement producer in North America, must continue to tender cash deposits based on related customs values of imports and dumping margins.

Consumption and Trade

Cross-border trade of both cement and clinker with the United States varies considerably from year to year depending on demand. Canadian cement production efficiencies and a lower-valued Canadian dollar continue to make Canadian cement and clinker competitive in U.S. markets. Annual exports of cement to the United States amount to 3-4 Mt and account for about one third of total Canadian shipments. These shipments are mainly destined for the southern Great Lakes region and the northwestern Pacific states. Canada's annual imports of cement are about 0.5 Mt directed mainly to the northern Great Lakes region and the two most westerly provinces.

Low-cost marine transportation has influenced world trade considerably. Total U.S. imports of cement (excluding clinker) for consumption were about 18 Mt in 1998, or 17% of apparent consumption.

Technology

Energy conservation programs by the Canadian cement industry have reduced the energy consumption per unit of production by about 25% since 1974. Although the number of kilns has decreased, their individual capacities have increased and the more efficient dry-process plants will account for more than 95% of total clinker capacity when Lafarge Canada's Richmond plant is fully on stream in the year 2000. The fuel mix has changed considerably away from natural gas and petroleum products toward coal and/or coke. In 1997, of 17 clinker-producing plants, 8 reported using coal and/or coke as their primary fuel. Eight plants reported using waste as an alternative or supplemental fuel, according to the Canadian Portland Cement Association (CPCA). Waste was used at one plant as a primary fuel. In 1997, the Canadian cement industry consumed, on average, 4637 megajoules per tonne of production, of which 4071 megajoules (88%) were derived from fossil fuels (Table 2).

Suitable waste materials are an attractive alternative fuel because pyro-processing accounts for more than 80% of total energy needs, or 30-40% of total production costs. In the context of sustainable development, it is apparent that improved waste management involving combustion technology is leading to greater conservation of non-renewable fossil fuels.

NRCan announced in October 1998 its creation of the International Centre for the Sustainable Development of the Cement and Concrete Industry. Although this centre will draw on some current initiatives and the expertise of the Canada Centre for Mineral and Energy Technology (CANMET), it will be dependent on new partnerships with industry, academic institutions, and other governments for strengthening global efforts relevant to the sustainable development of cement and concrete. Ideas, advice and financial support for the new International Centre are being sought in order to promote the use of environmentally friendly and energy-efficient materials.

CANMET is involved in specialized R&D and in major technical and coordinating roles. This organization continued its Advanced Concrete Programs, which contribute to infrastructure durability, waste reduction and energy saving.

Based on an agreement with the Electric Power Research Institute (EPRI) of Palo Alto, California, CANMET is involved in a multi-year, cost-shared contract on blended cements. Past cooperative research into supplementary cementing materials (SCMs) has led to the production of a ground granulated blast furnace slag for use as a cementitious material in concrete. (As noted above in the Canadian industry section under Ontario, SLC will produce slag granules to be used as a relatively low-cost, low-energy-intensive SCM in both Canada and the United States.)

In 1998, international conferences sponsored by the Committee for the Organization of CANMET/ACI Conferences, as well as others, included the Sixth CANMET/ACI International Conference on Fly Ash, Silica Fume, Slag and Natural Pozzolans in Concrete in Bangkok, Thailand, and the CANMET/ACI/JCI Fourth International Conference on Recent Advances in Concrete Technology in Tokushima, Japan. Also in 1998, CANMET, along with ACI, the National Research Council (NRC), Environment Canada, and Public Works and Government Services Canada, sponsored the Three-Day CANMET/ACI International Symposium on Sustainable Development of the Cement and Concrete Industry.

In April 1999, the above-mentioned committee, as well as others, will sponsor the two-day CANMET/ACI International Symposium on Concrete Technology for Sustainable Development to be held in Vancouver. In 2000, this committee will sponsor two international conferences: the Fifth CANMET/ACI International Conference on Durability of Concrete from June 4 to 9 in Barcelona, Spain, and the Sixth CANMET/ACI International Conference on Superplasticizers and Other Chemical Admixtures in Concrete from October 10 to 13 in Nice, France.

Research efforts to develop new superplasticizers for use in conjunction with supplementary cementing materials for high-performance concrete have increased in recent years. As a result of this, a new publication entitled *Superplasticizers: Properties and Applications in Concrete*, by Ramachandran, Malhotra, Jolicoeur and Spiratos, was compiled to integrate the chemistry and applications concerned. This publication, which includes 14 chapters and more than 400 pages, can be obtained from the Materials Technology Laboratory (MTL) of Natural Resources Canada's CANMET by contacting Lynn Stafford at tel. (613) 995-8815.

Also during 1998, Natural Resources Canada, mainly in collaboration with the Canadian Industry Program for Energy Conservation (CIPEC), continued to develop long-term strategies related to major energy-consuming sectors, including cement and lime.

OUTLOOK

Cement shipments in 1999 are expected to increase mainly based on relatively low interest rates, continued recent strength in both residential and non-residential building construction, and a stable demand for exports.

In 1998, housing starts were about 137 000, according to the Canada Mortgage and Housing Corporation. By way of comparison, housing starts were 125 000 in 1996, 149 000 in 1997, and are expected to be about 145 000 in 1999. With real economic growth in both Canada and the United States forecast to continue, the outlook continues to be positive for the office and industrial building sectors. (Further information can be obtained on the Internet at www.cmhc-schl.gc.ca/cmhc.html.)

Energy management will continue to concentrate on gains in efficiency based on timely switching among the available choices of common fuels. However, most longer-term cost savings are expected to result from the partial substitution of fossil fuels by waste-derived fuels. For example, in the case of Refuse Derived Fuel (RDF), about 70% (by volume) of municipal solid waste from post-recycled curbside garbage could be extracted for use by the cement industry. This would reduce by about two thirds the volume of material for disposal as landfill. Under certain circumstances using RDF, reductions in requirements for traditional fuels have been predicted to be as high as 20-25%.

The use of supplementary cements incorporating fly ash, silica fume or other pozzolans, and classified accordingly as various types of blended cements, is expected to become more important in modern cement and concrete practices.

Notes:* *(1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of February 1, 1999.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
25.23	Portland cement, aluminous cement, slag cement, supersulphate cement and similar hydraulic cements, whether or not coloured or in the form of clinkers				
2523.10	Cement clinkers	Free	Free	Free	Free
	Portland cement:				
2523.21	White cement, whether or not artificially coloured	Free	Free	Free	Free
2523.29	Other	Free	Free	Free	Free
2523.30	Aluminous cement	Free	Free	Free	Free
2523.90	Other hydraulic cements	Free	Free	Free	Free
68.10	Articles of cement, of concrete or of artificial stone, whether or not reinforced Tiles, flagstones, bricks and similar articles:				
6810.11	Building blocks and bricks	3%	Free	Free	Free
6810.19	Other	5%	Free	Free	Free
6810.91	Prefabricated structural components for building or civil engineering	5%	Free	Free	Free
6810.99	Other				
6810.99.10	Pipes	5%	Free	Free	Free
6810.99.90	Other	5%	Free	Free	Free

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999.

TABLE 1. CANADA, CEMENT PRODUCTION AND TRADE, 1996-98

Item No.		1996		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
PRODUCTION[1] (all forms)							
	Ontario	5 211 930	384 570	5 247 620	446 497	5 425 250	477 265
	Alberta	x	x	x	x	x	x
	Quebec	2 849 392	207 379	2 610 187	209 200	2 629 000	214 551
	British Columbia	1 743 203	176 566	1 822 108	175 373	1 883 786	187 458
	Nova Scotia	x	x	x	x	x	x
	Newfoundland	x	x	x	x	x	x
	Total	11 587 365	964 380	11 736 272	1 062 708	12 064 000	1 126 875
IMPORTS							
2523.10	Cement clinker						
	Thailand	–	–	–	–	76 507	4 743
	Mexico	–	–	58 195	3 316	78 802	3 711
	Bermuda	–	–	27 096	1 807	20 811	1 018
	Lebanon	–	–	–	–	10 995	479
	United States	41	2	15	1	288	24
	Belgium	–	–	25 730	1 712	–	–
	Total	41	2	111 036	6 836	187 403	9 975
2523.21	Portland cement, white, whether or not artificially coloured						
	United States	3 834	670	9 096	1 484	13 166	2 530
	Mexico	–	–	–	–	2 690	493
	Germany	29	5	–	–	448	69
	Other countries	67	16	189	34	281	63
	Total	3 930	693	9 285	1 518	16 585	3 155

TABLE 1 (cont'd)

Item No.		1996		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)							
2523.29	Portland cement, n.e.s.						
	United States	569 570	41 945	588 974	44 030	497 177	40 021
	Lebanon	–	–	–	–	5 450	597
	Colombia	–	–	2 423	249	2 757	300
	France	–	–	977	109	2 123	170
	Mexico	–	–	–	–	753	75
	Other countries	5 533	1 764	7 972	435	217	15
	Total	575 103	43 709	600 346	44 823	508 477	41 178
2523.30	Aluminous cement						
	United States	10 391	5 434	10 936	6 523	13 586	8 075
	France	84	66	139	76	270	156
	Other countries	77	49	3	. .	3	1
	Total	10 552	5 549	11 078	6 599	13 859	8 232
2523.90	Hydraulic cement, n.e.s.						
	United States	37 232	5 043	29 875	5 055	45 594	5 871
	Belgium	–	–	3 425	698	9 770	2 279
	United Kingdom	1 329	343	2 412	583	3 636	715
	Japan	681	134	275	79	334	92
	Colombia	2 020	203	1 638	164	773	77
	China	–	–	1	. .	634	72
	Other countries	821	206	249	62	541	122
	Total	42 083	5 929	37 875	6 641	61 282	9 228
6810.11	Building blocks and bricks of cement, concrete or artificial stone						
	United States	. .	1 301	. .	1 600	. .	2 800
	Brazil	–	–	–	–	. .	61
	United Kingdom	. .	155	. .	295	. .	49
	Other countries	. .	17	. .	29	. .	1
	Total	. .	1 473	. .	1 924	. .	2 911
6810.19	Tiles, flagstones and similar articles of cement/concrete or artificial stone						
	United States	. .	11 963	. .	15 490	. .	17 625
	Italy	. .	1 058	. .	1 142	. .	1 280
	Malta	–	–	. .	403	. .	175
	Portugal	. .	35	–	–	. .	132
	Spain	. .	55	. .	89	. .	128
	India	. .	46	. .	264	. .	77
	Israel	–	–	. .	2	. .	41
	Germany	. .	85	. .	115	. .	24
	Other countries	. .	400	. .	146	. .	127
	Total	. .	13 642	. .	17 651	. .	19 609
6810.20	Pipes of cement or concrete	–	–	–	–	–	–
6810.91	Prefabricated structural components of buildings, etc., of cement/concrete, etc.						
	United States	. .	3 060	. .	2 470	. .	6 906
	United Kingdom	. .	474	. .	962	. .	899
	Other countries	. .	43	. .	134	. .	111
	Total	. .	3 577	. .	3 566	. .	7 916
6810.99	Articles of cement, of concrete or of artificial stone, n.e.s.						
	United States	. .	11 912	. .	14 354	. .	16 695
	China	. .	661r	. .	1 256	. .	3 957
	United Kingdom	. .	234	. .	647	. .	1 041
	Mexico	. .	94	. .	178	. .	333
	Italy	. .	422	. .	302	. .	245
	Philippines	. .	46	. .	83	. .	228
	Hong Kong	. .	24	. .	50	. .	215
	Germany	. .	398	. .	86	. .	100
	France	. .	25	. .	4	. .	51
	Other countries	. .	181r	. .	131	. .	73
	Total	. .	14 197r	. .	17 091	. .	22 938
EXPORTS							
2523.10	Cement clinker						
	United States	1 252 863	72 324	1 019 308	72 025	1 696 195	94 087
	Total	1 252 863	72 324	1 019 308	72 025	1 696 195	94 087

TABLE 1 (cont'd)

Item No.		1996		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)							
2523.21	Portland cement, white, whether or not artificially coloured						
	United States	134 818	17 317	215 058	25 062	481 350	51 218
	St. Pierre and Miquelon	153	23	92	17	122	23
	Other countries	221	34	–	–	75	27
	Total	135 192	17 374	215 150	25 079	481 547	51 268
2523.29	Portland cement, n.e.s.						
	United States	3 953 140	259 010	4 086 333	290 508	3 745 283	258 066
	St. Pierre and Miquelon	1 087	188	451	83	361	63
	Singapore	18	9	–	–	20	12
	Other countries	98	31	60	5	–	–
	Total	3 954 343	259 238	4 086 844	290 596	3 745 664	258 141
2523.30	Aluminous cement						
	Philippines	172	6	–	–	–	–
	Total	172	6	–	–	–	–
2523.90	Hydraulic cement, n.e.s.						
	United States	10 942	2 649	28 644	7 098	72 446	12 554
	Chile	10	39	–	–	123	71
	Singapore	10	9	77	33	93	67
	Bolivia	–	–	–	–	10	40
	Other countries	836	435	353	216	72	32
	Total	11 798	3 132	29 074	7 347	72 744	12 764
6810.11	Building blocks and bricks of cement, concrete or artificial stone						
	United States	. .	15 034	. .	24 538	. .	35 964
	Taiwan	–	–	–	–	. .	257
	Japan	. .	163	. .	257	. .	161
	Ukraine	–	–	. .	87	. .	156
	India	. .	53	. .	54	. .	42
	Netherlands	–	–	–	–	. .	25
	Other countries	. .	1 370	. .	107	. .	22
	Total	. .	16 620	. .	25 043	. .	36 627
6810.19	Tiles, flagstones and similar articles of cement/concrete or artificial stone						
	United States	. .	15 497	. .	16 188	. .	23 226
	Japan	. .	29	. .	954	. .	2 484
	Russia	–	–	. .	28	. .	16
	Other countries	. .	398	. .	247	. .	20
	Total	. .	15 924	. .	17 417	. .	25 746
6810.20	Pipes of cement or concrete	–	–	–	–	–	–
6810.91	Prefabricated structural components of buildings, etc., of cement/concrete, etc.						
	United States	. .	62 836	. .	60 334	. .	68 593
	Guatemala	–	–	–	–	. .	538
	United Kingdom	. .	120	. .	444	. .	84
	Bermuda	. .	11	–	–	. .	46
	Japan	–	–	. .	30	. .	30
	Other countries	. .	165	. .	188	. .	75
	Total	. .	63 132	. .	60 996	. .	69 366
6810.99	Articles of cement, of concrete or of artificial stone, n.e.s.						
	United States	. .	30 243	. .	41 816	. .	45 466
	United Kingdom	. .	24	. .	3 259	. .	1 975
	Italy	–	–	. .	14	. .	250
	Honduras	–	–	–	–	. .	177
	Japan	. .	76	. .	216	. .	63
	Chile	. .	17	. .	16	. .	51
	United Arab Emirates	–	–	–	–	. .	40
	France	–	–	–	–	. .	37
	Other countries	. .	480	. .	369	. .	141
	Total	. .	30 840	. .	45 690	. .	48 200

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; n.e.s. Not elsewhere specified; p Preliminary; x Confidential.
[1] Producers' shipments plus quantities used by producers.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CEMENT PLANTS, APPROXIMATE ANNUAL GRINDING CAPACITY, END OF 1997

Company	Plant	Wet (W) Dry (D) Preheater (x) Precalciner (c)	Fuel (Coal, Oil, Gas, Waste)	No. of Kilns	Grinding Capacity	Clinker Capacity
					(000 t/y)	
ATLANTIC REGION						
Lafarge Canada Inc.	Brookfield, N.S.	D	C,Wa	2	610	476[b]
North Star Cement Limited	Corner Brook, Nfld.	Dx	O,Wa	1	245	158
Subtotal, Atlantic region				3	855	634
QUEBEC						
Lafarge Canada Inc.	St. Constant	D	C,Wa	2	1 160	950
Ciment Québec Inc.	St. Basile	W,Dc	C,O,G,Wa	3	995	1 077[a]
St. Lawrence Cement Inc.	Joliette	D	C,Wa	4	1 475	900
Subtotal, Quebec region				9	3 630	2 927
ONTARIO						
Lafarge Canada Inc.	Woodstock	W	C	2	775	509
	Bath	D	C	1	1 090	987
Federal White Cement Ltd.	Woodstock	Dx	O	1	200	184
ESSROC Canada Inc.	Picton	D,Dx	C,G	2	792	1 125
St. Lawrence Cement Inc.	Mississauga	W,Dc	C,O,Wa	3	1 987	1 759[a]
Blue Circle Canada Inc.	Bowmanville	Dc	C	1	1 213	1 550
	St. Marys	Dx	C,G	1	788	680
Subtotal, Ontario region				11	6 845	6 794
PRAIRIE REGION						
Lafarge Canada Inc.	Exshaw, Alta.	D,Dc	G	2	1 388	1 075
Inland Cement Limited (Cimenteries CBR/Heidelberger)	Edmonton, Alta.	Dc	G	1	1 380	930
Subtotal, Prairie region				3	2 768	2 005
BRITISH COLUMBIA						
Lafarge Canada Inc.	Kamloops	D	C,G	1	278	205
	Richmond	W	G,Wa	2	480	508
Tilbury Cement Limited (Cimenteries CBR/Heidelberger)	Delta	Dx	C,G,Wa	1	1 000	1 105
Subtotal, B.C. region				4	1 758	1 818
Total Canada (9 companies)				30	15 856	14 178

Source: Market and Economic Research Department, Portland Cement Association.
[a] Two kilns inactive. [b] One kiln inactive.
Note: Total active kiln capacity including white cement is approximately 13.1 Mt/y.

TABLE 3. CANADA, CEMENT PLANTS, KILNS AND CAPACITY UTILIZATION, 1980-98

	Clinker-Producing Plants	Kilns	Approximate Cement Grinding Capacity	Portland and Masonry Cement Production[1]	Clinker Exports	Approximate Total Production[2]	Capacity Utilization
			(t/y)	(t)	(t)	(t)	(%)
1980	23	47	16 363 000	10 274 000	726 087	11 000 087	67
1981	23	48	16 771 000	10 145 000	524 006	10 669 006	64
1982	23	48	16 771 000	8 418 000	290 329	8 708 329	50
1983	23	49	17 900 000	7 870 878	404 793	8 275 671	46
1984	23	49	17 900 000	9 387 466	440 297	9 827 763	55
1985	23	49	17 900 000	10 192 442	676 596	10 869 038	61
1986	23	49	17 900 000	10 611 223	324 000	10 935 223	61
1987	20	40	16 600 000	12 603 164	767 338	13 370 502	81
1988	20	40	15 506 000	12 349 873	331 796	12 681 669	82
1989	20	38	15 546 000	12 590 637	178 491	12 769 128	82
1990	20	38	16 439 000	11 745 152	460 075	12 205 227	74
1991	20	34	16 262 000	9 372 219	544 870	9 917 089	61
1992	18	34*	16 800 000	8 593 399	988 348	9 581 747	57
1993	18	34*	16 800 000	9 393 581	882 935	10 276 516	61
1994	18	34*	17 021 000r	10 584 414	981 024	11 565 438	68
1995	18	34*	16 157 000r	10 440 329	1 329 548	11 769 877	69
1996	18	32	16 252 000	11 587 365	1 252 863	12 840 228	79
1997	17	30	15 856 000	11 736 272	1 019 308	12 755 580	80
1998p	17	30	15 856 000	12 064 000	1 696 195	13 760 195	87

Sources: Statistics Canada; Portland Cement Association.
p Preliminary r Revised.
* Includes inactive kilns.
1 Producers' shipments and amounts used by producers. 2 Cement shipments plus clinker exports.

TABLE 4. CANADA, VALUE OF CONSTRUCTION BY TYPE, 1994-96

	1994	1995	1996
		($ millions)	
BUILDING CONSTRUCTION			
Residential	34 922	29 186	32 575
Industrial	3 006	3 243	4 227
Commercial	6 251	6 265	6 945
Institutional	4 931	4 982	4 906
Other	1 948	2 095	2 360
Total building	51 058	45 770	51 013
ENGINEERING CONSTRUCTION			
Marine	492	445	447
Transportation	6 032	6 436	5 874
Waterworks	904	1 140	1 358
Sewage, dams, sanitary systems	1 501	1 585	1 397
Electric power	3 965	3 441	2 934
Railway, telephones	1 446	1 298	1 880
Gas and oil facilities	13 721	13 474	12 891
Other	2 325	2 803	2 495
Total engineering	30 386	30 621	29 276
Total construction	81 444	76 391	80 289

Sources: Natural Resources Canada; Statistics Canada, catalogue no. 61-223 (additional information can also be obtained on the Internet at http://www.statcan.ca/english/Pgdb/Economy/Manufacturing/manuf18.htm or http://www.cmhc-schl.gc.ca/Mktinfo/store/#nho).
Notes: Numbers may not add to totals due to rounding. Expenditures include value of new construction and major renovation work purchased.

TABLE 5. WORLD PRODUCTION OF CEMENT, 1997 AND 1998•

	1997	1998•
	(000 tonnes)	
China	492 600	495 000
Japan	91 938	91 000
United States	84 255	87 200
India	80 000•	85 000
South Korea	60 000	59 000
Germany	37 000•	37 000
Italy	34 000	33 500
Turkey	36 000	37 000
Russia	26 600	25 000
Thailand	36 000•	34 000
Canada	11 736	12 100
Other countries	524 871	504 200
Total world	1 515 000•	1 500 000

Sources: Natural Resources Canada; U.S. Geological Survey, January 1999.
• Estimated.

Chrysotile

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In 1998, Canadian chrysotile shipments decreased by 23.9% from 1997 levels. Total shipments for 1998 were estimated to be 320 000 t valued at $167.2 million, compared to revised shipment figures for 1997 of 420 278 t valued at $214.9 million. Although the average price (for all shipments) increased by about 2.0%, prices for each fibre category remained stable at 1997 levels. Since the closure of the Baie Verte, Newfoundland, operation in 1994, the Canadian chrysotile industry is concentrated in Quebec. Production comes from three mines: the Black Lake and Bell mines operated by LAB Chrysotile, Inc. and the Jeffrey mine operated by J.M. Asbestos Inc.

Canadian exports of chrysotile in 1998 were an estimated 319 430 t. This represents a 25.7% decrease in volume from the previous year and a 36.6% decline when compared to 1996. The value of these exports decreased by 23.0% to $198.7 million.

In 1998, world production of chrysotile is believed to have increased by about 1.2% to reach 1.94 Mt. This increase is attributable mostly to higher production in China, while production in other countries is expected to have either remained stable at 1997 levels or to have decreased substantially such as in Canada, Russia, Kazakstan and South Africa, and especially in Greece where a mine closure occurred during the year.

Due to depressed markets, employment in the Canadian chrysotile industry decreased to about 1500 workers in 1998.

As a consequence of the European ban movement, but foremost because of the continued Asian financial crisis, worldwide chrysotile consumption will remain low compared to recent years. However, as a result of the drawdown of consumer stocks in 1998 and the start of a slow recovery in 1999 (mostly in Thailand, Malaysia, Indonesia and South Korea), worldwide chrysotile consumption should increase by 3-5% in 1999.

CHRYSOTILE, WORLD PRODUCTION BY COUNTRY, 1998

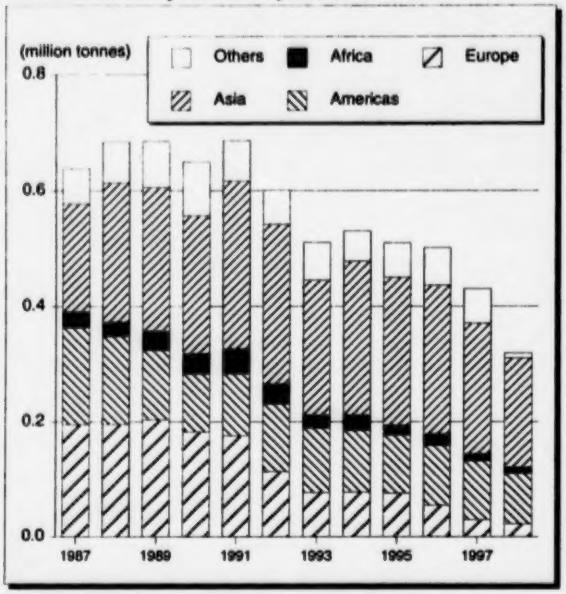
Country	Tonnes•
Russia	630 000
China	440 000
Canada	320 000
Brazil	198 000
Zimbabwe	130 000
Kazakstan	100 000
Greece	35 000
South Africa	25 000
Swaziland	25 000
India	25 000
United States	6 000
Colombia	4 500
Others	4 500
Total	1 943 000

Sources: Natural Resources Canada; U.S. Geological Survey.
• Estimated.

CHRYSOTILE AND ITS USES

Chrysotile (a natural fibrous hydrated silicate) is the only form of asbestos in the serpentine group. Crocidolite, amosite, anthophyllite, actinolite and tremolite form the amphibole group. Of these minerals, chrysotile is the least dangerous to human health and is the only one extracted in Canada. Chrysotile, which is sensitive to acid, tends to dissolve in the lungs, unless these are overburdened from exposure to excessive levels in the occupational environment. All fibres that enter the lungs cause mechanical irritation. In the past, most of the problems associated with chrysotile have been due to the poor working practices that existed then in both the handling and use of chrysotile. With the marked improvements in today's work practices and the increased protection of workers, the occupational risks associated with chrysotile have been tremendously reduced and are controllable with existing technology.

Figure 1
Canadian Chrysotile Exports, 1987-98



Sources: Natural Resources Canada; Statistics Canada.

Because of their chemical and physical properties, chrysotile fibres are an extremely useful material that has been, and still is being, widely used throughout the world. In Canada, chrysotile fibres are classified into seven groups, each one with its own subcategories, with the longest fibres assigned to Group 1 and the shortest to Group 7. In decreasing length, chrysotile has been used in textiles, clothing, packings, woven brake linings, clutch facings, electrical insulation materials, high-pressure and marine insulation, asbestos-cement pipe, other asbestos-cement products (e.g., sheets and mouldings, shingles), gaskets, paper products, vinyl sheet backings, and millboards. The shortest fibres (Group 7) are used in moulded brake linings and as a filler in cement, plastics, roof coatings and caulking compounds. Some 90% of all chrysotile produced globally is used in asbestos-cement products such as pipes, plates and sheets; 7% in friction products such as brake linings and clutch facings; and 3% in textiles, clothing and various other uses. Low-density and friable products are no longer marketed and are prohibited in Canada under the *Hazardous Products Act*.

CANADIAN DEVELOPMENTS

In 1998, due to the closure of the British Canadian operations on November 1, 1997, and to 24 weeks of temporary mine closures split between the company's two remaining mines, the production level of LAB Chrysotile, Inc. (the largest Canadian chrysotile producer) was 29.9% lower than in 1997 at 193 000 t. The company made up for its lower production by drawing from its inventory, which had been restocked in 1997. During the year, employment at LAB Chrysotile stood at 1097 workers, including some 150 workers reassigned from the former British Canadian mine.

At LAB Chrysotile's Bell mine, which is the only underground chrysotile operation in Canada, current reserves at the 1450 production level will permit operations to continue until the end of 1999. Production will then be transferred to the 1750 level where the company plans to have its $30 million development project, which started in 1997, completed by the end of fall 1999. These reserves, identified in a 1995 drilling program, will ensure the mine's life into the next century.

At its Black Lake operation, LAB Chrysotile pursued its $40 million slope stabilization project. Reserves at this site are sufficient for the next 13 years at current production rates.

In 1998, the production level at J.M. Asbestos Inc. declined to 116 000 t, compared to 179 660 t in the previous year. The drop in production, brought about by lower consumer demand, forced the company to proceed during the year with periodic shut-downs of operations and temporary layoffs. The company's work force dropped from a high of 700 employees and 50 contract workers to 400 workers by early 1999.

Despite financial pressure put on it by plummeting market demand, the company pursued the development of an underground operation to extend the life of the Jeffrey mine. Completion of the access ramp in 1997 enabled work on production and haulage ramps, as well as on the preparation of the ore zones, to proceed during 1998. This work will be pursued in 1999 while completing the sinking of the production shaft and installation of the 7000-hp friction hoist will be carried out as scheduled. Construction of the underground mine is expected to be completed by the end of 2000.

Production at J.M. Asbestos Inc. will then be transferred from the open pit to the underground mine over a period of 12 months. Lower market demand enabled the company to stockpile 3.5 Mt of ore necessary to ensure a smooth transition period. The new underground operation will have a maximum capacity of 250 000 t/y of chrysotile fibre until 2020. The capital cost of this development is estimated to be $135 million. The underground mine project is financed from the operation's cash flows and from a $65 million loan of which 70% was guaranteed by the Quebec government in October 1998 through "Investissement-Québec." J.M. Asbestos has already invested $60 million in the project.

Following the signature in 1997 of an agreement to sell J.M. Asbestos Inc.'s magnesium-rich serpentine tailings to Magnola Metallurgy Inc. (Magnola), the latter company undertook the development of a magnesium metal production project in Asbestos. Mostly owned by Noranda Inc., Magnola started construction of a $730 million plant in May 1998, which is slated to be completed by spring 2000. At full capacity, the plant is expected to employ 375 workers and to produce 56 000 t/y of magnesium metal, mostly to be used as an alloying element in the automobile industry.

J.M. Asbestos pursued implementation of the ISO program to obtain ISO 9002 certification on quality assurance and ISO 14 000 certification on environmental protection. The company expects to be certified by the end of 1999.

After spending nearly $10 million during the past three years at the site of the old Cassiar Mining Corporation operations in northern British Columbia, the Toronto, Ontario-based company Minroc Mines Inc. commissioned a pilot plant in October 1998 to test the wet milling process used for the production of fibres from the tailings stockpile. Kilborn-SNC-Lavalin is preparing a "turn-key" proposal to boost the annual output of the wet milling complex to 36 000 t. Production from this operation could start in 2000. The tailings represent a resource of 16 Mt of ore grading 4.4% chrysotile.

In addition to pursuing the wet milling project in 1998, an effort made to delineate conventional ore reserves on the property to feed a dry circuit in the former Cassiar mill permitted the identification of 6.1 Mt of surface ore. The company plans to commission, by mid-1999, a re-activated circuit of the former dry mill to process the conventional ore at a production rate of 18 000 t/y. The company is confident that it will recapture the Asian asbestos-cement sheet and pipe markets it had formerly served.

International and Regulatory Developments

The Americas

Latin America

Brazil is an important producer of chrysotile, especially for the increasingly active Latin American market. Sociedade Anonima Mineraçao do Amianto (SAMA) produced about 198 000 t in 1998, a decrease of 5% from 1997. SAMA's mine is located at Minaçu in the state of Goiás. The company has programs for waste site reforestation, the treatment of mine and mill waste-waters, and dust control (through the use of wet recovery processes).

During 1998, the Brazilian chrysotile industry increased its activities to promote the safe use of chrysotile asbestos in its client countries in accordance with the international industry's responsible use policy. Brazilian union officials participating in activities in Europe in defence of the chrysotile industry also visited a fibre cement product plant in a country where asbestos fibres were substituted by cellulose fibres in the course of that country's ban of asbestos in 1993. Health and safety conditions at the plant were found to be deficient to ensure appropriate protection of workers, reinforcing the claim by some health and safety experts that the switch to asbestos substitutes is often accompanied by a lowering of the level of protection for workers.

The Asbestos International Association (AIA) regional program for Latin American countries, the AIA/CLAS (Confederación Latinoamericana del Asbesto), was again very active during the year. The objective of the program is to foster regional cooperation and identify joint priorities for action in Latin America in the context of broader efforts to gain wider global acceptance of the controlled use approach for chrysotile. It is a firm commitment on the part of industry in all of the participating countries to implement the International Labour Organization Convention 162 on Safety in the Use of Asbestos.

In 1998, the AIA/CLAS, in collaboration with the Asbestos Institute, carried out missions to four Latin American countries (Colombia, Mexico, Cuba and Panama). The objectives of the various missions were to promote the safe use of chrysotile asbestos, to assist in the implementation of the responsible use policy, and to emphasize the need for better dialogue between industry and governments. This was achieved either through: 1) meetings with consuming industry and government officials to evaluate the state of the situation; 2) information seminars attended by industry and government officials; or 3) in countries where the implementation of the responsible use policy is at a more advanced stage, through seminars specialized on industrial ventilation and dust control.

The Third Conference of Mining Ministries of the Americas held in Buenos Aires, Argentina, on November 9, 1998, resulted in the *Buenos Aires Declaration*, which includes an endorsement of the Safe Use Principle for minerals and metals. In this declaration the ministers and heads of delegation agreed: "To adopt, implement and communicate management policies aimed at continuous improvement within their countries and to promote the safe use of minerals and metals, regionally and internationally, taking into account the Conclusions of the Experts who attended the Pan-American Workshop on the Safe Use of Minerals and Metals held in Lima, Peru (July 1-3, 1998)." This declaration was signed

by Argentina, Bolivia, Brazil, Canada, Colombia, Costa Rica, Cuba, Chile, the Dominican Republic, Ecuador, Guatemala, Haiti, Mexico, Nicaragua, Paraguay, Peru, Uruguay, the United States and Venezuela.

United States

The U.S. Geological Survey estimated 1998 Canadian chrysotile imports into the United States at 15 704 t compared to 20 659 t in 1997. Canada remains the largest exporter (99.2%) of chrysotile to the United States, which also produces chrysotile fibres at the King City Asbestos Corporation (KCAC) New Idria mine near Coalinga, California. Shipments from this mine amounted to about 6000 t in 1998, down from 6900 t in 1997.

In the United States, asbestos was consumed in roofing products (48%), friction products (29%), gaskets (17%) and other products (6%). Although no longer manufactured in the United States, asbestos-cement pipes are currently being imported from Mexico into the United States where there remains an important demand for this product in southwestern states. The United States' main import based on tonnage is, however, asbestos-cement sheets, panels and tiles, while based on value its main import is friction products such as brake linings and pads. Total asbestos imports in 1998 amounted to about $138.7 million, an increase of 16.9% compared to 1997.

U.S. exports of chrysotile fibres, mainly to Japan and Mexico, continued to decline due to reduced demand in these countries. U.S. exports of asbestos-containing products (mostly brake linings and other friction material) to several countries, including Australia, Canada, Germany, Japan, South Korea, Mexico, the United Kingdom and Venezuela, amounted to just over $194 million, down 4% from 1997.

Europe

Belgium

Following the Belgian Council of Ministers' agreement on January 30, 1998, a Royal Decree banning the production, trade and use of asbestos, as well as any product containing this fibre, was signed on February 21, 1998. Initially planning to implement EU Directive 91/659 regarding asbestos, Belgium changed its course and adopted a more restrictive measure. The Royal Decree is the text of EU Directive 91/659 but with the following measures added: 1) the ban of asbestos-cement for building materials as of October 1, 1998; 2) the ban of friction materials for building applications/heavy industrial vehicles as of January 1, 1999; 3) the ban of friction materials for aircraft as of January 1, 2002; and 4) the ban of closings of high-pressure and calorific pipings (gaskets) as of January 1, 2002.

European Commission

The European Union's (EU) Member State Working Group of Experts met in Brussels July 22-23, 1997, to: 1) receive a consultant's (Environmental Resources Management Group (ERM)) draft final report on the *Recent Assessments of the Hazards and Risks Posed by Asbestos and Substitute Fibres, and Recent Regulation of Fibres World-Wide*; and 2) address a possible move towards a ban on the use of asbestos. The European Commission (EC) then mandated ERM to look at the socio-economic impact of the issue.

On December 16, 1997, the Directorate General III (Industry) of the EC requested the opinion of the Directorate General XXIV (Consumer Policy and Consumer Health Service) on the ERM report. On February 9, 1998, following its peer review of the ERM report, the Scientific Committee on Toxicity, Ecotoxicity and the Environment (SCTEE) of the Directorate General XXIV stated in its report that, "The ERM report provides no new evidence which indicates that a change in the risk assessment for chrysotile is appropriate." On substitute materials, the SCTEE's comments echoed those from a group of international scientists mandated by the Canadian government and its partners to complete a peer review of the ERM report. In effect, the SCTEE mentioned that ". . . there is no significant epidemiology base to judge the human health risks (of substitutes) . . . hence the conclusion that specific substitute materials pose a substantially lower risk to human health, particularly public health, than the current use of chrysotile, is not well founded . . ."

However, following the September 14, 1998, adoption of the U.K. Health Department's Advisory Committee on the Carcinogenicity of Chemicals in Food, Consumer Products and the Environment (COC) report (reflecting the U.K. assessment on the lesser risk of substitute products) by the SCTEE, the EC's Directorate General III moved ahead and made a ban proposal to member countries, which includes a phase-in period until 2005. The EC is expected to submit a proposal for the modification of an existing Directive at the next meeting of the Technical Progress Committee (TPC) in the first half of 1999, since this approach does not require any consultation with the Council of Ministers, nor with the European Parliament. If approved by the TPC, the proposal would then be adopted by the EC.

At the end of 1998, four countries (Greece, Ireland, Portugal and Spain) remained determined to continue using chrysotile while its continued use in the United Kingdom was being debated.

France

The French government's decision to ban the import, manufacture and sale of most asbestos products,

which was announced on July 3, 1996, became effective January 1, 1997.

Because the French decision was based on a report (*Health Effects of the Main Types of Asbestos Exposure*) from a credible French scientific body, the Government of Canada undertook to have this Institut National de la Santé et de la Recherche Médicale (INSERM) report reviewed by a panel of international experts hired by the Royal Society of Canada. The main findings of this review (which was peer-reviewed) were: 1) that there are no new scientific data that would justify a change in policy concerning the use of chrysotile asbestos; and (2) that the INSERM report over-estimated the real risks to the French population, mainly because of the lack of realistic exposure data. These findings are very important for Canada as they reinforce its "controlled use" position that was adopted in the early 1980s.

Following diplomatic exchanges between Canada and France at the end of September 1997, the French government indicated its willingness to have further consultations to resolve the asbestos issue. These consultations, termed the "Kouchner process" in reference to French Secretary of State Bernard Kouchner, would include a second meeting between Canadian and French experts to discuss public health risks associated with the use of asbestos, followed by a visit by Minister Kouchner. These meetings, held respectively on April 15-18, 1998, and May 4, 1998, did not result in resolution of the issue.

On July 7, 1998, following recommendations in its earlier report, the INSERM released a summary of the conclusions of an expert panel on the health effects of several asbestos substitute fibres. This study was conducted at the request of the Health Branch and the Labour Relations Branch of the French Department of Employment and Solidarity as a follow-up to the process that began with the INSERM expert panel on asbestos. The main conclusions reported are that: 1) because the "fibre" structure of asbestos is a major pathogenic factor, any new fibre proposed as an asbestos substitute (or for any other use) should automatically be suspected of being pathogenic because of its structure; 2) it was not possible to reach a firm conclusion on the cancer risk posed by substitutes because of a lack of data, especially epidemiological data; and 3) "most likely, similar concentrations of asbestos fibres (as are used currently in experiments to test the carcinogenicity of asbestos substitute fibres) would have yielded results of little or no significance in carcinogenicity studies."

- **World Trade Organization**

  On May 28, 1998, the Canadian government announced its decision to initiate an action at the World Trade Organization (WTO) for the settlement of the dispute with France on the issue of chrysotile asbestos. The government's objective in doing so is to maintain market access for all mineral and metal products, including chrysotile asbestos, in accordance with the Safe Use Principle of the Government of Canada's Minerals and Metals Policy.

  Consultations, the first step under the dispute settlement procedures of the WTO, were held on July 8, 1998, in Geneva. Unfortunately, this process did not enable Canada and France to find a mutually satisfactory resolution to the issue.

  On October 8, 1998, the Government of Canada formally asked the WTO to establish a dispute settlement panel for the resolution of the dispute with France on the issue of chrysotile asbestos. This request was accepted by the WTO Secretariat on November 25, 1998. The selection of the three panel members who will hear the case began in December 1998 and was ongoing at the end of the year. Once the panellists are appointed, the dispute settlement panel will receive written submissions by Canada and the European Commission (representing France) before proceeding to a first hearing. Written rebuttals will then be provided by both parties before a second hearing is held. After a due process, the panel will issue an interim report to both parties followed by a final report to rule on the issue. This report will likely be made public in the fall of 1999.

  Brazil, Zimbabwe and the United States have reserved third-party rights to participate in the panel proceedings. Brazil and Zimbabwe will participate in support of Canada's position, while the United States' interests are mostly judicial.

Greece

The Zidani chrysotile mine in Greece, which returned to production in 1993 under the terms of a renewable five-year lease to Hellenic Mineral Mining Co. Ltd. (HMMC), temporarily shut down in 1998. Its estimated production of chrysotile fibres in 1998 is 35 000 t, or half of what it produced in 1997. The country's asbestos-cement industry, comprising three companies (Hellenic Plastics S.A. (Hellenit), General Company of Building Materials (GEDY), and Incocimenti S.A.), operated with a 45 000-t/y finished product capacity in 1998.

United Kingdom

In accordance with its 1997 commitment to follow a due process in the introduction of new legislation to limit the import, supply and use of chrysotile asbestos and to base its decisions on sound science, the United Kingdom proceeded with two consultations during 1998.

Following up on a March 11, 1998, decision to delay amendments to its Asbestos (Prohibitions) Regulations until the position on the scientific evidence about substitutes became clearer, the U.K. held consultations between April 17 and July 31, 1998, on regulatory proposals to provide greater protection for workers from exposure to asbestos.

On August 18, 1998, based on "authoritative conclusions" drawn by a U.K. Health Department Advisory Committee on the Carcinogenicity of Chemicals in Food, Consumer Products and the Environment (COC) regarding the greater safety of substitutes, the U.K.'s Health and Safety Commission held a second consultation between September 17 and December 17, 1998, on proposals for amendments to the Asbestos (Prohibitions) Regulations 1992.

Participating in these consultations, two sets of submissions (one joint at the international level referred to in the "International Activities" section later in this chapter, and the other Canadian), were provided to the U.K.'s Health & Safety Executive. The latter submission by the Government of Canada, the Government of Quebec, the Asbestos Institute, Canadian chrysotile mining companies, and labour unions restated Canada's policy on the safe and responsible use of chrysotile and voiced arguments against ban measures, including the Health & Safety Commission's (HSC) own evaluation that the costs of banning would exceed the benefits of such a measure.

The HSC also published, on December 16, 1998, a "guidance on substitutes for white asbestos" that will enable it to pursue an active enforcement policy concerning substitution. The United Kingdom is expected to introduce new legislation restricting the use and import of asbestos in step with similar changes in mid-1999 at the European Union level.

Other Producers

China

Chrysotile asbestos production in China is estimated at 440 000 t in 1998, mostly emanating from the country's western provinces of Xinjiang and Qinghai and the eastern provinces of Liaoning and Hebei. This production is slated for domestic consumption in the manufacturing of asbestos-cement products used in the development of the country's infrastructure. Asbestos consumption in China is expected to keep pace with the increasing construction activity that may result in an increase in imports.

Kazakstan

Chrysotile asbestos production in Kazakstan comes from the Kostanai region where the Joint Stock Combine (JSC) Kostanaiasbest operates the Dzhetygarinsk open-pit mine. Production in 1998 is estimated at 100 000 t, down from 150 000 t in 1997.

Russia

Russia, the world's largest asbestos producer, is estimated to have produced 630 000 t of chrysotile asbestos in 1998, a reduction of about 11% from 1997. The Russian chrysotile mining industry consists of three companies: JSC Uralasbest, JSC Orenburgasbest, and JSC Tuvaasbest, who operate four open-pit mines located in the Urals (3) and in the Tuva region (1) north of Mongolia. An important portion of the country's production is for domestic consumption or is transformed before being exported. About 30% is said to be exported as fibre concentrates while the rest is used to manufacture asbestos-cement products (80%) and technical products (20%) such as friction material products, thermal and electric insulation materials, etc.

South Africa

Asbestos production in the Republic of South Africa decreased to approximately 25 000 t of chrysotile fibres in 1998, or about half the output in 1997, due to production problems experienced by Msauli Asbes Beperk, which operates an underground mine and processing plant in the Barberton area of Mpumalanga. The rest of South Africa's production comes from two small operators: Kaapsehoop Asbestos and Stella Asbestos, who both operate mines in the same area as above and supply the local markets.

The drop in production also resulted from the closure in early 1997 of the country's last producing crocidolite (blue asbestos) mine located in the Northern Cape Province; it was operated by Griqualand Exploration and Finance Co. (GEFCO). Rehabilitation work at the mining and milling site should be completed in 1999.

The Government of South Africa hosted a National Asbestos Summit on November 24-26, 1998, to review all issues related to the use of asbestos. This summit was essentially a rousing call to initiate a process to deal with the legacy of past mining practices and uses. The main conclusions of the summit were the need to: 1) strengthen South Africa's regulatory system on the controlled use of asbestos; 2) intensify the rehabilitation of asbestos mining dumps; 3) review the compensation and other remedial systems for the recognition of occupational illnesses and compensation to affected workers; and 4) prohibit the use of non-chrysotile asbestos.

Swaziland and Zimbabwe

In Swaziland, production at the HVL Asbestos (Swaziland) Ltd.-owned Havelock underground chrysotile mine is estimated to have decreased by 7% to 25 000 t compared to 1997. Similarly, at Zimbabwe's Shabanie & Mashaba asbestos mines, chrysotile production is reported to have dropped by

8% from the 1997 production level and forced the company to lay off part of its work force. These drops in production were brought about by lower demand in Asian markets and also, in the case of Zimbabwe, by political instability.

Responsible Use Policy

To demonstrate its support for the promotion and implementation of the responsible use policy adopted by the chrysotile producers and exporters of five countries (Brazil, Canada, Swaziland, Zimbabwe and South Africa, the latter of which signed in January 1998), the Canadian government signed, on March 3, 1997, a memorandum of understanding (MOU) in support of the responsible use policy with Canadian chrysotile producers. This MOU commits the government to assist the industry in encouraging the governments of asbestos-consuming countries to endorse the responsible use policy and to develop appropriate regulations where they do not already exist.

The responsible use policy, a voluntary industry policy aimed at increasing workers' protection worldwide, resulted from a 1994 meeting and was signed in late 1995/early 1996. The ultimate objective of this new policy, to be known as the "Responsible Use of Chrysotile," is to supply chrysotile only to those users that are in compliance with their respective national regulations or that have submitted a written commitment with an action plan in order to be in full compliance with their national regulations. The responsible use policy is based on the recognition and acceptance of the principles of the 1986 International Labour Organization Convention 162 and Code of Practice on Safety in the Use of Asbestos.

Acting on a conclusion of The International Conference on the Safe and Responsible Use of Chrysotile Fibres held in Montréal on September 16-19, 1997, that "chrysotile producers should export their technology and their expertise with their fibre," the Asbestos Institute in 1998 travelled to Mexico, Cuba, India, Panama, Morocco, Lebanon, Colombia, Algeria and Thailand to hold information seminars and/or training sessions to promote the safe use of chrysotile.

Developed by the Asbestos Institute in cooperation with labour and the governments of Canada and Quebec, the program, which began in October 1997, is aimed at providing Canadian expertise to train workers in targeted consuming countries in order to increase their knowledge of safe and responsible chrysotile asbestos manufacturing techniques. Supported by Natural Resources Canada, this training program promotes the International Labour Organization's Convention 162 on Safety in the Use of Asbestos.

Activities for the promotion of the safe use of chrysotile planned for 1999 include visits to over seven consuming countries.

International Activities

In parallel with its efforts to assist the Canadian chrysotile industry in the implementation of the producers' responsible use policy, the Canadian government is also consulting with other chrysotile-producing countries (Brazil, Russia, South Africa, Swaziland and Zimbabwe) in order to develop a strategy to further enhance the promotion of the safe use of chrysotile in consuming countries. Five meetings were organized with industry and government representatives of these countries during 1998 to coordinate activities led either by industry, governments or labour to promote the safe use principle as applied to chrysotile asbestos worldwide. These activities include: 1) the presentation to European Union officials of an Aide-Mémoire expressing the producing countries' views on chrysotile and its safe use; 2) a July 31, 1998, submission to the United Kingdom's consultations on the amendment of its asbestos regulations and supporting approved codes of practice; and 3) the meeting, on October 20, 1998, between a union delegation comprising representatives from Angola, Brazil, Canada, India, Portugal, Russia, Swaziland and Zimbabwe and officials from the European Commission to raise their concerns relative to the EC's project to ban asbestos.

Visits to the Canadian chrysotile industry by journalists from Belgium, Morocco and the United Kingdom in 1998, and from Latin America (Chile, Colombia, El Salvador, Panama and the Dominican Republic) in January 1999 were organized to ensure a broader dissemination of the safe use principle to the benefit of consumers, regulators and industries in consuming countries.

OUTLOOK

As a consequence of the European ban movement, but foremost because of the Asian financial crisis, worldwide chrysotile consumption will remain depressed in 1999 compared to pre-1997 levels. However, signs of a recovery in Thailand at the end of 1998 may indicate a gradual resumption in demand in Asian countries in 1999, especially in Thailand, Malaysia, Indonesia and South Korea. Demand from Japan, which was still battling at the end of the year to stabilize and reorganize its financial system, is expected to remain depressed in 1999. Already felt in 1997 (lower demand in Asian markets was felt starting in mid-1997), the Asian crisis resulted in a decrease in Canadian exports to Asian countries of 39% compared to 1996 levels. The combination of a gradual increase in consumption in Asian countries

and a need for consumers to re-stock inventories drawn down in 1998 will likely result in increased exports in 1999. Canadian producers, who export about 60% of their production to Asia (while the European market only accounts for about 6%), are expecting a 3-5% increase in their total sales in 1999. The full recovery of the Asian market is not expected before 2002.

In Europe, the loss of France as a major consumer, and the impact of its ban decision on chrysotile consumption in other European consuming countries, led to a 59% decrease in exports to the area in 1998 compared to 1996. It is, however, comforting to see that the last European countries with a chrysotile industry, particularly Spain, Portugal, Greece and Turkey, appear determined to continue using the product.

In developing countries, the benefits and safety of chrysotile-cement products continue to be recognized despite increasing competition from substitute fibres and galvanized steel. In particular, chrysotile-cement pipes are essential to the distribution of potable water and irrigation in many countries where aggressive soils and economic conditions are not appropriate for substitute products. Asian countries are still the main markets for Canadian fibres, accounting for just under 60% of Canadian exports in 1998. Japan remained the preferred destination during the year, despite a 31% drop in imports compared to 1997, while exports to Thailand, the area's second highest, fell by 50%. One of the rare countries to register an increase in 1998 (for the second year in a row) is India where exports grew by 10% and are expected to remain strong for the next few years, mainly due to increased demand for infrastructure. Indonesia and South Korea continued to be very significant markets in 1998, but exports fell by 45% and 63% respectively compared to 1997. Exports to these two countries are expected to recover gradually in 1999 when the effect of the monetary crisis subsides.

The Americas increased its relative position as an important destination for Canadian chrysotile, accounting for over 27% of Canada's exports. However, this increase only reflects a smaller incremental reduction in imports compared to Canada's other international markets since exports to most countries of the Americas decreased relative to 1997. This decrease in demand was brought about by the impact of the Asian financial crisis on the export-based economies of these countries. In 1998, Mexico's imports decreased by 19% compared to 1997 as a result of a marked downturn in its economy; exports to Mexico in 1999 should improve slightly. However, Canadian exports to Cuba in 1998 decreased by 33% compared to 1997, remaining at a level 49% higher than in 1995; in 1999, Cuba should continue to be an important destination for Canadian chrysotile. Exports to the United States decreased by about 24% in 1998 compared to 1997, but are expected to stabilize at this level for the coming years. Canadian chrysotile exports to Colombia, Brazil and Chile decreased by 4%, 2% and 42% respectively compared to 1997. The only significant increase in imports reported were to El Salvador (122%), Ecuador (73%) and the Dominican Republic (155%).

In Africa, Canadian exports fell significantly in 1998, most notably in Morocco and Tunisia, whereas exports to Algeria and Nigeria recovered part of the volume lost in recent years as a result of social unrest and/or competitive Russian exports to these regions. Canadian exports to the Middle East, mostly to the United Arab Emirates and Egypt, increased by 35% compared to 1997.

The aggressive introduction of new chrysotile-containing products to address current health concerns may help turn markets around in the medium term.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of February 1, 1999.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2524.00.10	Crude asbestos	Free	Free	Free	Free
2524.00.90	Other asbestos	Free	Free	Free	Free
6811.10	Corrugated sheets of asbestos-cement, of cellulose fibre-cement or the like	5%	Free	Free	Free
6811.20	Sheets, panels/tiles, etc., of asbestos-cement, cellulose fibre-cement, etc.	5%	Free	Free	Free
6811.30	Tubes, pipes, and tube or pipe fittings of asbestos-cement, of cellulose fibre-cement, etc.	5%	Free	Free	Free
6811.90	Other articles of asbestos-cement, of cellulose fibre-cement, or the like	5%	Free	Free	Free
6812.10	Fabricated asbestos fibres; mixtures with a basis of asbestos or with a basis of asbestos and magnesium carbonate	Free	Free	Free	Free
6812.20	Asbestos yarn and thread	Free	Free	Free	Free
6812.30	Asbestos cords and string, whether or not plaited	Free	Free	Free	Free
6812.40	Asbestos woven or knitted fabric	Free	Free	Free	Free
6812.50	Asbestos clothing, clothing accessories, footwear and headgear	15.5%	Free	Free	Free
6812.60	Asbestos paper, millboard and felt	Free	Free	Free	Free
6812.70	Compressed asbestos fibre jointing, in sheets or rolls	Free	Free	Free	Free
6812.90	Other asbestos fabricated products n.e.s.	Free	Free	Free	Free
6813.10.10	Asbestos brake linings and pads for motor vehicles of heading nos. 87.02, 87.03, 87.04 or 87.05	7%	Free	Free	Free
6813.10.90	Other asbestos brake linings and pads	5%	5%	Free	Free
6813.90.10	Asbestos clutch facings for motor vehicles of heading nos. 87.02, 87.03, 87.04 or 87.05	Free	Free	Free	Free
6813.90.90	Other asbestos friction material and articles	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999.
n.e.s. Not elsewhere specified.

TABLE 1. CANADA, ASBESTOS PRODUCTION AND TRADE, 1997 AND 1998

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
PRODUCTION (Shipments)					
	By type				
	Group 3, spinning	4 788	5 490	. .	. .
	Group 4, shingle	92 569	78 342	. .	. .
	Group 5, paper	94 123	55 207	. .	. .
	Group 6, stucco	147 297	56 507	. .	. .
	Group 7, refuse	81 501	19 364	. .	. .
	Total	420 278	214 910	320 000	167 200
	By province				
	Quebec	420 278	214 910	320 000	167 200
	Newfoundland	–	–	–	–
	Total	420 278	214 910	320 000	167 200
EXPORTS					
2524.00.10	Crude asbestos				
	United States	1 831	497	3 209	783
	Japan	962	374	276	109
	Total	2 793	871	3 485	892
2524.00.21	Asbestos milled fibres, Group 3 grades				
	EC countries (12)[1]				
	Spain	248	321	396	653
	Portugal	72	95	93	125
	Germany	11	15	–	–
	EC countries, subtotal	331	431	489	778
	Mexico	1 097	1 420	1 104	1 562
	United Arab Emirates	–	–	738	1 218
	Algeria	–	–	400	660
	Hungary	213	276	342	564
	Turkey	734	952	332	527
	Peru	230	298	288	374
	Cuba	1	1	301	370
	India	185	242	248	298
	South Korea	466	604	219	284
	Other countries	1 011	1 255	569	656
	Total	4 268	5 479	5 030	7 291
2524.00.22	Asbestos milled fibres, groups 4 and 5 grades				
	EC countries (12)[1]				
	Spain	7 250	6 841	6 399	6 320
	Portugal	2 219	2 074	2 815	2 646
	United Kingdom	1 792	1 479	619	408
	Greece	–	–	115	131
	Ireland	648	416	171	110
	Germany	55	76	70	94
	France	21	22	18	33
	Belgium	1 456	1 400	–	–
	Denmark	13	9	–	–
	EC countries, subtotal	13 454	12 317	10 207	9 742
	Japan	35 370	33 026	26 757	25 015
	India	17 917	14 436	20 610	16 693
	Colombia	10 416	9 122	12 380	10 587
	Thailand	31 655	22 808	14 515	10 143
	Mexico	13 409	11 135	9 734	7 976
	Brazil	7 154	6 359	7 564	6 639
	Malaysia	4 909	3 849	4 953	3 947
	Sri Lanka	4 025	3 962	3 768	3 622
	Indonesia	9 418	6 560	5 101	3 442
	United Arab Emirates	2 485	2 310	3 163	3 100
	South Korea	6 046	3 242	4 718	3 057
	Cuba	6 346	4 769	3 636	2 621
	Algeria	2 136	1 970	3 020	2 554
	Egypt	2 123	2 268	2 363	2 428
	Nigeria	2 071	1 498	2 966	2 321
	Chile	3 652	3 181	1 984	1 692
	Other countries	20 113	17 233	15 152	13 006
	Total	192 699	160 045	152 591	128 585

TABLE 1 (cont'd)

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
2524.00.29	Asbestos shorts, groups 6, 7, 8 and 9 grades				
	EC countries (12)[1]				
	Portugal	1 974	612	2 674	956
	Spain	2 188	978	1 924	822
	United Kingdom	2 014	696	781	235
	Ireland	1 033	411	239	95
	Germany	48	16	108	37
	Belgium	914	373	–	–
	Denmark	113	57	–	–
	Greece	36	9	–	–
	EC countries, subtotal	8 320	3 152	5 726	2 145
	Japan	48 603	19 647	31 117	12 995
	India	25 917	11 433	27 762	11 366
	Thailand	38 455	17 554	20 794	8 909
	United States	18 748	5 557	12 341	3 814
	Mexico	11 635	3 903	10 431	3 488
	South Korea	24 187	8 712	6 382	2 172
	Indonesia	11 241	4 766	6 244	2 170
	Colombia	8 108	3 366	5 395	2 067
	Brazil	5 431	1 756	4 940	1 863
	Malaysia	5 935	2 389	4 223	1 751
	Taiwan	3 529	1 470	3 628	1 557
	Other countries	20 373	7 998	19 341	7 659
	Total	230 482	91 703	158 324	61 956
Grand total, crude, milled fibres and shorts		430 242	258 098	319 430	198 724
6811.10	Corrugated sheets of asbestos-cement, of cellulose fibre-cement, or the like				
	United States	..	16	..	8
	Total	..	16	..	8
6811.20	Sheets n.e.s., panels/tiles, etc., of asbestos-cement, cellulose fibre-cement, etc.				
	United States	..	1 247	..	11 340
	Japan	..	94	..	70
	Cuba	..	758	..	52
	Guinea	–	–	..	9
	Liberia	–	–	..	5
	Ukraine	..	26	–	–
	Total	..	2 125	..	11 476
6811.30	Tubes, pipes and tube or pipe fittings of asbestos-cement, of cellulose fibre-cement, etc.				
	United States	..	5	–	–
	Total	..	5	–	–
6811.90	Articles n.e.s. of asbestos-cement, of cellulose fibre-cement, or the like				
	United States	..	111	..	422
	Taiwan	–	–	..	18
	Total	..	111	..	440
6812.10	Fabricated asbestos fibres; mixtures with a basis of asbestos or with a basis of asbestos and magnesium carbonate				
	United States	..	21	..	50
	Cuba	–	–	..	6
	Taiwan	..	12	–	–
	Mexico	..	56	–	–
	Total	..	89	..	56

TABLE 1 (cont'd)

Item No.		1997		1998P	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
6812.20	Asbestos yarn and thread				
	Brazil	94	451	178	791
	Venezuela	52	280	74	368
	Iran, Islamic Republic of	29	88	30	90
	United Kingdom	19	65	14	75
	Uruguay	–	–	14	70
	Uganda	–	–	14	67
	United States	1	21	1	18
	Other countries	33	115	–	–
	Total	218	1 020	325	1 479
6812.30	Asbestos cords and string, whether or not plaited				
	United States	. .	23	. .	22
	Cuba	–	–	. .	5
	Total	. .	23	. .	27
6812.40	Asbestos woven or knitted fabric				
	United Kingdom	124	1 083	67	604
	United States	30	387	23	341
	Brazil	–	–	25	155
	Japan	–	–	2	49
	Other countries	23	277	–	–
	Total	177	1 747	117	1 149
6812.50	Asbestos clothing, clothing accessories, footwear and headgear				
	Singapore	–	–	. .	29
	Taiwan	–	–	. .	14
	Cuba	. .	18	–	–
	Total	. .	18	. .	43
6812.60	Asbestos paper, millboard and felt				
	United States	–	–	. .	19
	Taiwan	–	–	. .	17
	Total	–	–	. .	36
6812.70	Compressed asbestos fibre jointing, in sheets or rolls				
	United States	. .	1 028	. .	947
	Other countries	. .	262	. .	155
	Total	. .	1 290	. .	1 102
6812.90.10	Asbestos building material, n.e.s.				
	India	–	–	. .	21
	Cuba	–	–	. .	17
	United States	. .	11	–	–
	United Arab Emirates	. .	31	–	–
	China	. .	59	–	38
	Total	. .	101	. .	76
6812.90.90	Other asbestos fabricated products, n.e.s.				
	United States	. .	114	. .	51
	Other countries	. .	66	. .	31
	Total	. .	180	. .	82
6813.10	Asbestos brake linings and pads				
	United States	. .	43 184	. .	48 769
	Other countries	. .	294	. .	570
	Total	. .	43 478	. .	49 339

TABLE 1 (cont'd)

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
6813.90	Asbestos friction material and articles, n.e.s.				
	United States	. .	7	. .	62
	Venezuela	. .	43	–	–
	Total	. .	50	. .	62
Total exports, asbestos manufactured		. .	308 351	. .	264 081
IMPORTS					
2524.00.10	Crude asbestos	–	–	82	78
2524.00.90	Other asbestos	–	–	57	30
6811.10	Corrugated sheets of asbestos-cement, of cellulose fibre-cement, or the like	198	154	70	80
6811.20	Sheets n.e.s., panels/tiles, etc., of asbestos-cement, cellulose-fibre cement, etc.	1 145	1 411	1 355	1 485
6811.30	Tubes, pipes, and tube or pipe fittings of asbestos-cement, cellulose fibre-cement, etc.	488	436	659	565
6811.90	Articles n.e.s., of asbestos-cement, cellulose fibre-cement or the like	120	609	169	856
6812.10	Fabricated asbestos fibres; mixtures with a basis of asbestos or with a basis of asbestos and magnesium carbonate	13	165	9	77
6812.20	Asbestos yarn and thread	2	10	3	24
6812.30	Asbestos cords and string, whether or not plaited	15	80	21	165
6812.40	Asbestos woven or knitted fabric	40	551	29	401
6812.50	Asbestos clothing, clothing accessories, footwear and headgear	11	265	12	273
6812.60	Asbestos paper, millboard and felt	. .	278	. .	382
6812.70	Compressed asbestos fibre jointing, in sheets or rolls	127	1 508	86	942
6812.90.10	Asbestos belting	. .	5	–	–
6812.90.90	Other asbestos fabricated products n.e.s.	. .	2 455	–	–
6813.10	Asbestos brake linings and pads	. .	69 002	. .	66 484
6813.90	Asbestos friction material and articles n.e.s.	. .	8 274	. .	6 683
Total imports		. .	85 278	. .	81 022

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available or not applicable; n.e.s. Not elsewhere specified; p Preliminary.
1 EC includes Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain and the United Kingdom.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADIAN CHRYSOTILE PRODUCERS, 1998

Producers	Mine Location	Normal Mill Capacity Ore/Day	Fibre/Year	Remarks
		(tonnes)		
Teranov Mining Corp.	Baie Verte, Nfld.	6 000	20 000	Wet-processing of tailings started in July 1991. Jointly owned by Black Hill Minerals Ltd. (50%) and Cliff Resources Corporation (50%). Did not produce since 1994.
LAB Chrysotile Inc.[1]				Partnership owned 55% by LAQ and 45% by Mazarin Mining Corporation Inc.
- Lac d'Amiante du Québec, Ltée (LAQ)	Black Lake, Que.	9 000	185 000	Open-pit. Since September 1989, LAQ has been owned by Jean Dupéré (President of LAB Chrysotile) and Connell Bros. Company, Ltd. of the United States.
- Asbestos Corporation Limited British Canadian mine	Black Lake, Que.	7 000	55 000	Sold to Mazarin Mining Exploration Inc. on September 2, 1992. Open-pit. Re-opened on July 8, 1996, on a slightly smaller scale; to close again on November 1, 1997.
- Bell Asbestos Mines, Ltd.	Thetford Mines, Que.	2 700	100 000	Sold to Mazarin Mining Exploration Inc. on September 2, 1992. Underground. Mine re-opened January 1989.
J.M. Asbestos Inc. Jeffrey mine	Asbestos, Que.	15 000	250 000	Open-pit (effective capacity reduced by one half since 1982).
Total of four producers at year-end			590 000	

[1] A partnership involving three operating companies.

TABLE 3. CANADA, ASBESTOS PRODUCTION AND EXPORTS, 1986-98

	Crude Asbestos	Milled Fibres	Short Fibres	Total
		(tonnes)		
PRODUCTION[1]				
1986	–	332 092	330 289	662 381
1987	–	365 144	299 402	664 546
1988	14	399 550	310 793	710 357
1989	–	410 588	303 448	714 036
1990	–	379 047	306 580	685 627
1991	–	335 506	350 502	686 008
1992	–	259 819	327 175	586 994
1993	–	235 908	287 059	522 967
1994	–	249 862	280 995	530 857
1995	–	255 621	259 932	515 553
1996	. .	241 188	265 088	506 276
1997r	. .	. .	. .	420 278
1998p	. .	. .	. .	320 000
EXPORTS				
1986	127	375 948	341 609	717 684
1987	1 696	353 321	293 808	648 825
1988	11 288	381 561	292 236	685 085
1989	17 198	379 601	312 915	709 714
1990	1 469	378 074	269 942	649 485
1991	2 302	353 391	330 360	686 053
1992	1 489	272 013	327 075	600 577
1993	1 739	229 000	279 695	510 434
1994	2 155	248 804	280 394	531 353
1995	968	251 251r	257 356	509 575
1996	911	239 111	263 985	504 007
1997r	2 793	196 967	230 482	430 242
1998p	3 485	157 621	158 324	319 430

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; p Preliminary; r Revised.
[1] Producers' shipments.

Coal

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Coal is an organically derived material. It is formed from the remains of decayed plant material compacted into a solid through millions of years of pressure and heat. Coal is the world's most abundant and widely distributed fossil fuel. About 4.6 billion metric tonnes (t) are mined annually in more than 40 countries. Coal is used primarily for the generation of electricity and production of steel. More than 40% of the world's electricity is generated from coal and about 70% of the world's steel is produced with coal. Coal is also used as an energy source in industrial processes (such as cement manufacture and pulp and paper) and to produce a wide range of products (such as tars and chemicals). In some developing countries, coal is still used as a residential heating fuel.

CANADIAN DEVELOPMENTS

In 1998, Canada was the world's fifth largest coal exporter and the ninth largest coal producer.

Production

In 1998, declining demand in export markets and production problems in Nova Scotia led to the first decline in coal production since 1992, according to preliminary estimates. Compared to 1997, production fell by 4.2%, or 3.3 Mt, to 75.4 Mt. The value of coal production declined 6.6% to $1.8 billion as lower demand in export markets drove coal prices downward. About 62% of the production was thermal coal and 38% was metallurgical coal.

Production occurs to meet domestic demand for thermal coal, which is used primarily for the generation of electricity, and to meet export demand, which primarily comprises metallurgical coal. Nearly all (97%) of Canada's coal is produced in the three westernmost provinces: the most production takes place in Alberta (48%), followed by British Columbia (33%) and Saskatchewan (16%). The remainder comes from Nova Scotia and New Brunswick.

British Columbia's coal production, all bituminous, decreased in 1998 by 3.1 Mt to 24.8 Mt. With virtually all of British Columbia's production exported, the decrease is a direct reflection of the lower demand in Asian export markets. Ninety-three percent of British Columbia's coal is metallurgical.

Alberta remained Canada's largest coal-producing province in 1998. Its production is estimated to be essentially unchanged at 36.4 Mt, consisting of 25.3 Mt of subbituminous coal (down 0.5 Mt from 1997) and 11.1 Mt of bituminous coal (up 0.5 Mt from 1997). About 85% of Alberta's production is thermal coal.

Saskatchewan was again the country's third largest coal-producing province. Its production, all lignite, was also up slightly to 11.8 Mt. All of Saskatchewan's coal is used for thermal purposes.

Nova Scotia's bituminous coal production was down 0.5 Mt to 2.1 Mt due to lower production by the Cape Breton Development Corporation (DEVCO), a federal Crown corporation. All of the coal produced in Nova Scotia in 1998 was thermal.

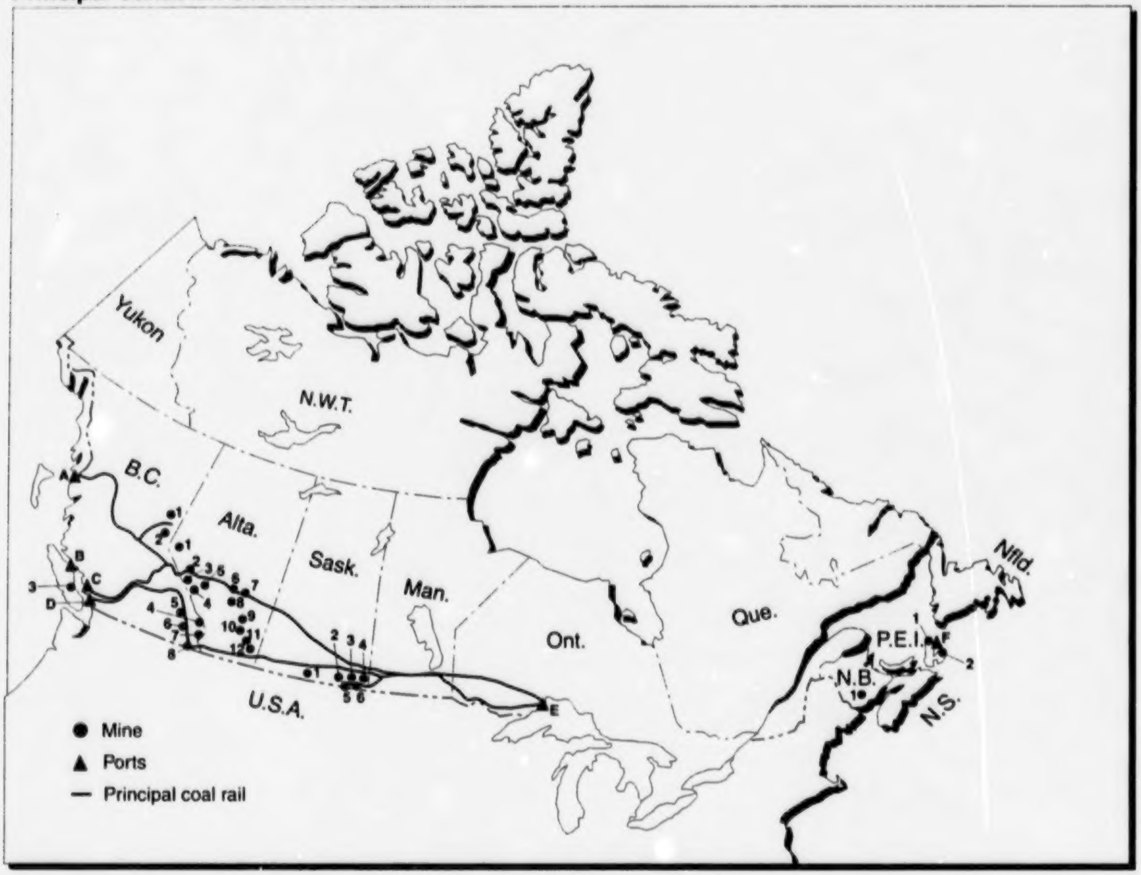
New Brunswick's bituminous coal production increased 0.1 Mt to 0.3 Mt. N.B. Coal Limited, the only coal producer in the province, is owned by, and sells exclusively to, the provincial electric utility, New Brunswick Power Corporation.

In 1998, there were 24 mines in operation in Canada, 20 of which were surface (strip or open-pit) mines, three were underground mines, and one was a combination of both. Most of the thermal coal produced for provincial electric utilities comes from mine-mouth operations, and nearly all of these are surface mines, which generally have lower production costs than underground mines.

Consumption

Canadian coal consumption in 1998 is estimated at 58.8 Mt, an increase of 3.1 Mt over 1997. This

Figure 1
Principal Canadian Coal Mines and Ports



● Mines

British Columbia
1. Bullmoose
2. Quintette
3. Quinsam
4. Fording River
5. Greenhills
6. Elkview
7. Line Creek
8. Coal Mountain

Alberta
1. Smoky River
2. Obed
3. Gregg River
4. Luscar
5. Coal Valley
6. Highvale
7. Whitewood
8. Genesee
9. Paintearth
10. Vesta
11. Sheerness
12. Montgomery

Saskatchewan
1. Poplar River
2. Utility
3. Boundary Dam
4. Costello
5. Shand
6. Bienfait

New Brunswick
1. Minto

Nova Scotia
1. Prince
2. Phalen

▲ Ports

British Columbia
A. Ridley Island
B. Texada Island Facility
C. Neptune
D. Roberts Bank

Ontario
E. Thunder Bay

Nova Scotia
F. International Pier

increase is due to higher consumption of coal to generate electricity. In 1998, an estimated 52.7 Mt of coal was consumed for electricity generation, about 4.1 Mt was used in steelmaking, and about 2.1 Mt was used by other industries, mainly cement.

British Columbia used about 0.2 Mt of bituminous coal for general industrial purposes.

Alberta, the largest coal-consuming province, used about 26.0 Mt of coal to generate electricity, slightly less than in the previous year. With the exception of about 0.6 Mt of Alberta bituminous coal, all of the coal consumed was subbituminous coal from Alberta.

In Saskatchewan, coal consumption by the electric utility was an estimated 9.8 Mt, similar to the previous year. All of the coal used by the utility comes from provincial lignite mines. About 0.2 Mt of local lignite was also used by industrial consumers.

While Manitoba does not produce coal, it consumes a small amount of coal for electricity generation and general industrial uses. Consumption in 1998 was 0.7 Mt, up slightly from 1997. More than 0.5 Mt was used for the generation of electricity with the rest being used by general industry.

Ontario was Canada's second largest coal consumer, using coal for electricity generation, steelmaking and general industrial purposes. Ontario's 1998 consumption of coal for the generation of electricity jumped by 3.3 Mt to 12.3 Mt. The higher coal use made up for the loss of nuclear power generation due to the temporary shut-down of seven units. About 80% of the coal consumed by the utility came from the United States; the rest was Canadian. The Canadian portion consisted of bituminous coal from Alberta and lignite from Saskatchewan.

Coal consumption by the steel industry in Ontario in 1998 is estimated to be 4.1 Mt, somewhat below the 1997 level of 4.5 Mt. All of the coal used by the steel industry is imported from the United States. Coal use by Ontario's industrial sector was up slightly from 1997 at less than 0.7 Mt.

While Quebec does not produce coal, it consumes a small amount for general industrial uses. The province's 1998 consumption was up slightly at 0.8 Mt. All of the coal consumed in Quebec (about half bituminous, half anthracite) is imported from the United States.

In New Brunswick, coal consumption in 1998 is estimated to be 1.4 Mt, up slightly from 1997 and all for the generation of electricity. Most of the coal was imported from the United States, Colombia and Venezuela, with a smaller amount being supplied by the one New Brunswick mine.

Nova Scotia's 1998 coal consumption was an estimated 2.6 Mt, down 0.4 Mt from 1997. Nearly all of this coal was used to generate electricity, with a tiny amount for general industrial use. Nova Scotia Power Inc., the provincial utility, bought over 80% of its coal from DEVCO and imported the remainder from the United States.

Exports

The downturn in the economies of Japan and other Asian countries in 1998 and an oversupply of coal on world markets led to reduced demand for Canadian export coal. Exports fell 5.5% to 34.2 Mt in 1998. Canadian coal was sold to 22 countries. About 83% of Canada's exports were metallurgical coal.

The single largest buyer of this coal was Japan. In 1998, Canadian coal exports to Japan were down by 1.7 Mt to 16.7 Mt. With a market share of about 13%, Canada was again Japan's second largest coal supplier after Australia. About 85% of Canadian coal exports to Japan were metallurgical coal.

In 1998, Canadian coal exports to South Korea, Canada's second largest market, were up about 0.2 Mt to 6.2 Mt. With a market share of more than 12%, Canada was South Korea's third largest coal supplier after Australia and China. About 64% of Canadian coal exports to South Korea were metallurgical coal.

Canada's next largest coal markets of at least 1 Mt were the United Kingdom (1.4 Mt), Taiwan (1.1 Mt) and Brazil (1.1 Mt).

With a 72% share of Canada's total exports, British Columbia remained the single largest exporting province, although its exports were down 2.8 Mt to approximately 24.5 Mt in 1998. About 94% of British Columbia's exports were metallurgical coal.

Alberta's coal exports were up 0.5 Mt to 9.7 Mt. About 54% of Alberta's exports were metallurgical coal.

Imports

Canada's 1998 coal imports were 18.7 Mt, up a very significant 39%, or 5.2 Mt above the 1997 level. Almost 98% of all imports came from the United States, with the remainder coming from Colombia, South Africa, China, Venezuela and Russia.

The electric power industry imported about 12.1 Mt. Ontario Power Generation, the single largest importer of coal, bought about 9.9 Mt of U.S. coal in 1998, up 3 Mt from the previous year. New Brunswick Power bought about 1.1 Mt, while Nova Scotia Power Inc. imported about 0.5 Mt and Manitoba Hydro imported about 0.5 Mt.

Metallurgical coal imports by the Ontario steel industry were estimated at 4.6 Mt in 1998, slightly higher than the 1997 level of 4.3 Mt. All of this coal came from the United States.

The remaining imports, all from the United States, went to industrial users located primarily in Quebec and Ontario.

Developments in the Canadian Coal Industry

The Canadian coal industry is undergoing major restructuring. In 1998, the largest producer, Manalta Coal, was acquired by the second largest producer, Luscar Ltd. The merged company (which kept the name Luscar) has a production capacity of about 41 Mt/y, which makes it the sixth largest producer in North America. Luscar Ltd. (with a 55% share of Canadian production), Fording Coal Ltd. (the second largest producer, with a 27% share) and Teck Corporation (third largest, with an 11% share) together account for about 93% of Canada's total coal production. Luscar Ltd. and Teck Corporation are public companies, while Fording is a wholly owned subsidiary of Canadian Pacific Ltd, a public company.

Four smaller producers account for the remaining 7%. These producers comprise: a federal Crown corporation (Cape Breton Development Corporation or DEVCO, operating the Prince and Phalen mines in Nova Scotia); a provincial Crown corporation (New Brunswick Coal, a wholly owned subsidiary of New Brunswick Power Corporation); a public company (Hillsborough Resources, parent company of Quinsam Coal Corp. in British Columbia); and a privately owned company (Smoky River Coal in Alberta). In early 1999, the federal government initiated a process to close the Phalen mine by the end of 2000 and sell the remaining DEVCO operations. Both Hillsborough Resources and Smoky River Coal encountered financial difficulties during the course of 1998.

The Smoky River mine suffered a major setback in 1998 after the failure of an expansion based on a new underground longwall. Smoky River returned to conventional surface mine operations, but financial problems forced the company to seek court protection from creditors. New management is now in place and Smoky River is confident that its restructuring plan will be acceptable to the creditors and the court. These plans must be filed and approved by the fall of 1999.

Deteriorating thermal coal export markets led to financial difficulties for the Quinsam mine on Vancouver Island. It requested court protection from its creditors. Restructuring plans must be filed and approved by the court before the end of 1999.

In June 1997, a joint federal-provincial environmental assessment panel determined that the proposed Cheviot open-pit mine near Hinton, Alberta, met all regulatory requirements, subject to a number of conditions. The Alberta Energy and Utilities Board approved the project and the Province of Alberta issued a mine development permit in August 1997. In August 1998, the Department of Fisheries and Oceans (DFO) issued a fisheries authorization for the project.

Environmental groups challenged the environmental assessment process through the legal process beginning in September 1997. In early April 1999, a judge of the Federal Court of Appeals found that the Canadian environmental assessment process had not been respected in four instances, and thereby rescinded the Fisheries authorization. By mid-1999, the Canadian Environmental Assessment Agency and the Province of Alberta had agreed to reconvene the joint federal-provincial assessment panel using the original terms of reference.

The Cheviot mine will be owned and operated by Cardinal River Coals Ltd. (CRC), a joint venture of Luscar Ltd. of Edmonton and Consol of Canada Inc. Production, all to be exported, would be about 3.5 Mt/y of metallurgical coal over an estimated mine life of 20 years. The work force would number about 500. The Cheviot mine will replace production from the existing Luscar mine some 20 km away where reserves are expected to be depleted in two to five years.

Pine Valley Coal Ltd. received approval under the B.C. *Environmental Assessment Act* and has various other permits in place for its proposed Willow Creek project, 45 km west of Chetwynd in central British Columbia. Pine Valley Coal is the operator for this joint venture of B.C. Rail, Globaltex Industries Inc. and Mitsui Matsushima Co. Ltd. The proposed open-pit mine would produce 0.9 Mt/y of coking and thermal coal for export over an estimated mine life of 15 years, with the potential to be extended. The work force would number about 100-120. At the time of writing (mid-1999), Pine Valley Coal was trying to find buyers for the proposed mine's output. Globaltex Industries Inc. is a Vancouver-based junior resource company listed on the Vancouver Stock Exchange.

Luscar is currently undertaking a review of the Telkwa coal property it acquired as a result of its acquisition of Manalta Coal. The proposed Telkwa mine is located approximately 6 km southwest of Telkwa in central British Columbia. Manalta Coal had already initiated the regulatory review process for the project. If Luscar decides to continue moving the project forward, a Final Report required under the B.C. *Environmental Assessment Act* could be submitted during the course of 1999.

The proposed open-pit mine would produce about 1-1.5 Mt/y of thermal and metallurgical coal for export over an estimated mine life of 25 years. The work force would number about 120-140. Production could start two years after completion of the regulatory process and coal sales arrangements.

EMERGING CLEAN COAL TECHNOLOGIES

Environmental challenges (see following section) are the main issue facing continued or increased coal utilization. On the coal combustion side, emissions of sulphur dioxide and nitrogen oxides have traditionally been the main concern. Proven technologies, such as flue gas desulphurization, low NO_x burners and fluidized bed combustion, are available — albeit at a cost — to reduce these emissions.

Recently, the issue of greenhouse gas emissions and climate change has emerged to be a more formidable and challenging one. Coal is at a disadvantage as it produces more carbon dioxide per unit of energy generated than other fossil fuels such as oil and natural gas. However, a number of new coal conversion technologies are being developed that could increase both the competitiveness and environmental acceptability of coal through increased thermal efficiency and reduced emissions of carbon dioxide, sulphur dioxide and nitrogen oxides. The challenge will be to commercialize these clean coal technologies so that coal can continue to be an attractive and low-cost fuel.

One group of clean coal technologies aims to increase the amount of electrical energy extracted from a unit of coal. The key here is higher overall conversion efficiency, which will reduce the emission of carbon dioxide. Technologies in this category include various advanced pulverized coal (PC) combustion technologies (subcritical, supercritical and ultra-supercritical), fluidized bed combustion (FBC) technologies (circulating and pressurized), and coal gasification combined cycle (CGCC) technologies. Efficiencies range from 40 to 50%, compared to 33-35% for a conventional PC unit.

Although not a coal conversion technology in itself, the possibility of capturing the carbon dioxide emitted by coal-burning plants and using and/or storing it in geological formations (sequestration) has started to receive significant attention. Efforts are currently under way to explore the feasibility of various schemes of this nature in western Canada.

A newly emerging group of technologies is set to produce a relatively pure stream of carbon dioxide at the tail end of a coal conversion plant. This stream can then be captured (and disposed of) at a much lower cost than the diluted carbon dioxide stream emitted by the first group of technologies. Technologies in this category are very new and still at various stages of research and development. They include the combustion of coal in a CO_2/O_2 recycle system and anaerobic, calcium oxide-assisted coal-to-hydrogen conversion.

THE ENVIRONMENT

Environmental protection is being addressed at all stages of the coal chain. At the mining stage, environmental assessments are an integral part of the provincial mine permitting process. In certain instances, mining projects also trigger a federal environmental review under the *Canadian Environmental Assessment Act*.

Environmental assessments ensure that activities associated with coal mining, including the removal of vegetation, relocation of overburden, construction of roads, blasting, mine operation and reclamation of previously mined areas, are carried out in a manner that minimizes any negative effect on the environment. Several Canadian coal mining companies have been recognized for their successful environmental mine management programs.

At the coal utilization stage, air emissions are a concern. Coal accounts for about 20% of sulphur dioxide (SO_2), 15% of nitrogen oxide (NO_x) and 20% of carbon dioxide (CO_2) emissions in Canada. Coal is also a source of heavy metals emissions.

In response to public concern about the environment, Canada is continually improving its domestic environmental guidelines and has participated in the development of a number of international agreements that affect coal and other fossil fuels. Specifically, Canada has signed several international protocols with commitments to reduce emissions of sulphur dioxide (1985 Helsinki and 1994 Oslo Protocols), nitrogen oxide (1988 Sofia Protocol) and carbon dioxide (1997 Kyoto Protocol). Canada also made a commitment, under the 1994 Canada-U.S. Air Quality Agreement, to limit sulphur dioxide emissions to 2.3 Mt/y in the seven easternmost provinces. By the year 2000, the cap under this agreement will be 3.2 Mt/y Canada-wide. Federal-provincial agreements to meet the 1994 target for eastern Canada have required coal-burning utilities in Ontario, New Brunswick and Nova Scotia to make large capital investments to reduce sulphur dioxide emissions.

A July 1998 report by Environment Canada showed that, in 1997, eastern Canadian coal-burning utilities, including Nova Scotia Power Inc., New Brunswick Power Corporation and Ontario Hydro, were all below their sulphur dioxide emission limits. However, acid deposition continued to be a concern. In October 1997, a multi-stakeholder Acidifying Emissions Task Group submitted a report, *Towards a*

National Acid Rain Strategy, with the key finding that in 2010, with full implementation of existing Canadian and U.S. programs to control sulphur dioxide emissions, 800 000 km^2 in southeastern Canada would continue to receive levels of acid rain harmful to aquatic systems. In response, a *Canada-Wide Acid Rain Strategy for Post-2000*, signed by Ministers in the fall of 1998, is establishing Canada's next-step targets and schedules for sulphur dioxide emissions in Ontario, Quebec, New Brunswick and Nova Scotia.

As for nitrogen oxide emissions, these are below the target established by the Sofia Protocol. In 1995, Environment Canada established a working group to develop guidelines for nitrogen oxide emissions from coal-fired utility boilers to be constructed after the year 2000. A technical background report was completed in 1996 and work is still ongoing.

New, Canada-wide air quality standards are currently (1999) under development. The federal government is also preparing Phase 3 of its smog management plan, which will likely target the mining industry for reductions in emissions of ozone precursors (nitrogen oxide and volatile organic compounds), sulphur dioxide and particulate matter.

With respect to heavy metals, the element that is of most concern from a health and environment perspective is mercury, with somewhat lesser attention focused on cadmium and lead. International concern is addressed through the United Nations Economic Commission for Europe, which finalized negotiation, in early 1998, of a protocol under the Convention on Long-Range Transboundary Air Pollution to address the transboundary impacts of heavy metals emissions. Canada ratified the Heavy Metal and Persistent Organics Pollutants Protocols in June 1998. Signatories will be required to adopt common emissions regulations and to apply Best Available Techniques (BAT) to reduce emissions from new and existing major emission sources. It was agreed that there is no proven BAT for controlling mercury emissions from coal-fired generating stations.

Canada is also actively engaged in the control of mercury emissions on a North American scale through its participation in the drafting of the Phase 2 Regional Action Plan on Mercury, scheduled for approval in early 2000. This plan will form the framework for mercury emissions and products management by the three NAFTA countries.

The burning of coal and other fossil fuels generates carbon dioxide, which may have an effect on global climate patterns. In December 1997, at the United Nations Framework Convention on Climate Change in Kyoto (Japan), Canada together with 150 other nations signed an international agreement that commits Canada to reduce its greenhouse gas emissions by 6% from 1990 levels by the years 2008-2012.

Work on a national strategy to achieve these reductions was initiated in early 1998. A federal/provincial Climate Change Secretariat was created with the mandate to develop, implement, coordinate and fund this national strategy.

The main path for Canadians to have input into the development of this national strategy was through a set of stakeholder committees called Issue Tables, which were set up during 1998. These committees, comprising representatives from governments, industry, academia and many other fields, provided expert and detailed input into the analysis, identification and assessment of greenhouse gas reduction and adaptative options. An Electricity Industry Issue Table was established in mid-1998. Its final report is due by the fall of 1999. This report and its options for emissions reduction, together with the reports from 15 other Issue Tables, will be considered by federal and provincial energy and environment ministers in March 2000.

In addition to air emissions, coal-fired electrical generating stations produce large volumes of fly ash, bottom ash and other waste products. Fly ash is a powder-like substance, while bottom ash is a coarser product. Fly ash utilization in the manufacture of cement is increasing and this results in significant environmental benefits, including reduced landfill costs for the utility as well as reductions in emissions of carbon dioxide, particulates, organic compounds and sulphur dioxide for the cement manufacturer. Since each tonne of cement produced releases one tonne of carbon dioxide, replacement of up to 25% of cement in concrete by fly ash (as is already commonplace in Canada) can result in a significant reduction of carbon dioxide emissions while improving the quality of the concrete. About 23 000 t of fly ash was contained in the cement used to build the new Confederation Bridge linking Prince Edward Island and New Brunswick. Other major uses for coal ash include road construction and backfill for mines. Flue gas desulphurization units produce large volumes of gypsum by-product. This material is increasingly being sold to wallboard manufacturers and again results in reduced landfill costs for the utility.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of October 31, 1999.

TABLE 1. COAL SUPPLY AND DEMAND, 1982-98

	Production	Imports	Total Supply	Exports	Domestic Consumption	Total Demand	Stock Changes and Adjustment
				(000 tonnes)			
1982	42 811	15 775	58 586	16 004	41 353	57 357	1 229
1983	44 780	14 667	59 447	17 011	43 649	60 660	(1 213)
1984	57 402	18 359	75 761	25 138	48 699	73 837	1 924
1985	60 854	14 620	75 474	27 378	48 666	76 044	(570)
1986	57 812	13 312	71 124	25 904	44 532	70 436	688
1987	61 211	14 345	75 556	26 741	50 140	76 881	(1 325)
1988	70 644	17 418	88 062	31 725	54 466	86 191	1 871
1989	70 529	14 521	85 050	32 827	53 795	86 622	(1 572)
1990	68 331	14 113	82 444	31 009	49 036	80 045	2 399
1991	71 138	12 417	83 555	34 112	50 173	84 285	(730)
1992	65 610	12 834	78 444	28 097	51 683	79 780	(1 336)
1993	69 027	8 392	77 419	28 313	48 979	77 292	127
1994	72 823	9 176	81 999	31 746	52 348	84 094	(2 095)
1995	75 036	9 684	84 719	33 992	52 773	86 766	(2 046)
1996	75 809	11 692	87 501	34 459	53 511	87 971	(470)
1997	78 651	13 480	92 131	36 182	55 734	91 916	215
1998	75 380	18 675	94 054	34 179	58 846	93 025	1 029

Sources: Natural Resources Canada; Statistics Canada.

TABLE 2. COAL DISPOSITION FROM MINES, 1998

	Nova Scotia	New Brunswick	Saskatchewan	Alberta	British Columbia	Canada
			(000 tonnes)			
DELIVERIES TO:						
Newfoundland	–	–	–	–	–	–
Prince Edward Island	–	–	–	–	–	–
Nova Scotia	2 112	–	–	–	–	2 112
New Brunswick	–	272	–	–	–	272
Quebec	–	–	–	–	–	–
Ontario	–	–	1 824	544	27	2 395
Manitoba	–	–	111	–	42	154
Saskatchewan	–	–	9 855	–	–	9 855
Alberta	–	–	–	26 024	–	26 024
British Columbia	–	–	–	10	321	331
Total Canada	2 112	272	11 790	26 578	390	41 142
Total ports	–	–	–	9 785	23 871	33 656
United States	–	–	–	24	558	582
Total	2 112	272	11 790	36 387	24 818	75 380

Sources: Natural Resources Canada; Statistics Canada.
– Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 3. COAL SUPPLY BY RANK, 1980-98

	Production				Imports				
	Bituminous	Sub-bituminous	Lignite	Total	Anthracite	Bituminous	Sub-bituminous	Total	Total Supply
	(million tonnes)								
1980	20.2	10.5	6.0	36.7	0.3	15.5	–	15.8	52.5
1981	21.7	11.6	6.8	40.1	0.4	14.4	–	14.8	54.9
1982	20.3	13.0	9.5	42.8	0.3	15.5	–	15.8	58.6
1983	22.5	14.5	7.8	44.8	0.3	14.4	–	14.7	59.4
1984	32.1	15.4	9.9	57.4	0.3	18.1	–	18.4	75.8
1985	34.4	16.8	9.7	60.9	0.1	14.5	–	14.6	75.5
1986	32.3	17.3	8.2	57.8	0.4	12.9	–	13.3	71.1
1987	32.7	18.5	10.0	61.2	0.1	14.2	–	14.3	75.6
1988	38.6	19.9	12.1	70.6	0.5	16.9	–	17.4	88.1
1989	38.8	20.9	10.8	70.5	0.2	14.3	–	14.5	85.1
1990	37.6	21.3	9.4	68.3	0.3	13.8	–	14.1	82.4
1991	39.9	22.2	9.0	71.1	0.2	12.2	–	12.4	83.6
1992	32.6	23.0	10.0	65.6	0.2	12.6	–	12.8	78.4
1993	35.3	23.7	10.0	69.0	0.3	8.1	–	8.4	77.4
1994	36.6	25.5	10.7	72.8	0.3	8.9	–	9.2	82.0
1995	38.6	25.6	10.8	75.0	0.4	9.3	–	9.7	84.7
1996	40.0	25.0	10.9	75.8	0.5	11.2	–	11.7	87.5
1997	41.2	25.8	11.7	78.7	0.4	13.0	–	13.5	92.1
1998	38.3	25.3	11.8	75.4	0.6	15.9	2.2	18.7	94.1

Sources: Natural Resources Canada; Statistics Canada.
– Nil.

TABLE 4. COAL PRODUCTION BY RANK AND VALUE, 1994-98

	1994		1995		1996		1997		1998	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
DOMESTIC[1]										
Bituminous										
Nova Scotia	3 509	217 000	2 460	161 178	3 110	183 718	2 680	. .	2 112	. .
New Brunswick	332	28 000	263	24 410	273	24 032	173	. .	272	. .
Alberta	10 196	319 000	11 615	337 985	11 164	349 836	10 561	. .	11 102	. .
British Columbia	22 608	894 000	24 350	967 073	25 422	1 026 577	27 802	. .	24 818	. .
Subtotal	35 645	1 458 000	38 688	1 490 645	39 969	1 584 163	41 216	. .	38 304	. .
Subbituminous										
Alberta	25 494	228 000	25 608	232 033	24 986	231 736	25 783	. .	25 285	. .
Lignite										
Saskatchewan	10 685	104 000	10 740	116 200	10 854	116 092	11 653	. .	11 790	. .
Total domestic	72 824	1 790 000	75 036	1 838 879	75 809	1 931 990	78 651	. .	75 380	. .
IMPORTED[2]										
Bituminous and anthracite	9 176	642 000	9 684	697 000	11 692	825 000	13 480	. .	18 675	. .
Total supply	82 000	2 432 000	84 719	2 535 879	87 501	2 756 990	92 131	. .	94 054	. .

Sources: Natural Resources Canada; Statistics Canada.
. . Not available. [1] F.o.b. mines. [2] Value at U.S. port of exit.

TABLE 5. EXPORTS OF CANADIAN COAL BY TYPE AND DESTINATION, 1998

Country	Metallurgical	Thermal	Total
		(000 tonnes)	
Japan	14 254	2 486	16 740
South Korea	3 977	2 199	6 176
United Kingdom	1 144	280	1 424
Taiwan	1 141	–	1 141
Brazil	1 009	127	1 136
United States	890	108	998
Italy	958	–	958
Germany	899	–	899
Belgium-Luxembourg	473	342	815
Turkey	584	–	584
Chile	264	287	551
France	548	–	548
Netherlands	510	–	510
Spain	298	–	298
Mexico	251	–	251
India	237		237
Portugal	229	–	229
Egypt	225	–	225
Pakistan	216	–	216
Romania	129	–	129
Sweden	110	–	110
Australia	2	1	3
Total	28 348	5 831	34 179

Sources: Natural Resources Canada; Statistics Canada.
– Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 6. COAL CONSUMED BY THERMAL POWER STATIONS, 1972-98

	Nova Scotia	New Brunswick	Ontario	Manitoba	Saskatchewan	Alberta	Total Canada
				(000 tonnes)			
1972	663	281	7 599	410	2 145	4 113	15 211
1973	585	193	6 615	386	2 806	4 474	15 059
1974	606	292	6 721	132	2 902	4 771	15 424
1975	571	248	6 834	323	3 251	5 345	16 572
1976	730	207	7 612	979	3 521	5 996	19 045
1977	572	198	8 795	1 113	4 304	7 461	22 443
1978	771	151	9 097	341	4 585	8 029	22 974
1979	644	198	9 901	73	4 956	9 181	24 953
1980	1 052	315	10 779	240	4 972	10 424	27 782
1981	1 126	515	11 460	332	4 935	11 445	29 813
1982	1 300	548	12 484	184	5 897	13 242	33 655
1983	1 400	564	13 025	109	6 625	14 492	36 215
1984	2 974	610	13 413	163	7 925	16 123	41 208
1985	2 235	521	10 985	253	8 290	18 112	40 396
1986	2 137	469	9 172	111	6 786	17 719	36 394
1987	2 077	526	12 016	457	7 672	19 077	41 825
1988	2 266	678	13 079	780	8 637	20 538	46 055
1989	2 141	705	12 809	327	8 534	21 410	45 839
1990	2 184	496	10 362	298	7 462	21 340	42 142
1991	2 290	426	10 850	232	7 548	22 480	43 826
1992	2 344	471	10 022	233	8 419	23 752	45 241
1993	2 416	506	7 004	178	8 428	24 194	42 726
1994	2 672	1 208	5 170	164	8 502	28 207	45 923
1995	2 578	1 304	6 707	117	9 597	26 201	46 504
1996	2 864	1 370	6 984	176	9 719	25 794	46 906
1997	2 986	1 327	9 012	106	9 820	26 258	49 508
1998	2 597	1 433	12 342	546	9 795	25 963	52 677

Sources: Natural Resources Canada; Statistics Canada.

TABLE 7. COAL DEMAND, 1989-98

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
					(000 tonnes)					
THERMAL ELECTRIC										
Canadian	37 447	35 858	36 413	38 612	38 470	42 017	41 289	41 260	41 469	40 601
Imported	8 392	6 284	7 413	6 629	4 256	3 906	5 215	5 646	8 036	12 075
Total	45 839	42 142	43 826	45 241	42 726	45 923	46 504	46 906	49 505	52 677
METALLURGICAL										
Canadian	–	–	–	–	–	227	288	101	–	–
Imported	5 918	4 996	4 906	4 886	4 665	4 552	3 901	4 345	4 490	4 119
Total	5 918	4 996	4 906	4 886	4 665	4 779	4 189	4 446	4 490	4 119
GENERAL INDUSTRY										
Canadian	608	465	461	602	664	541	769	770	578	539
Imported	1 430	1 433	980	954	924	1 105	1 312	1 389	1 162	1 512
Total	2 038	1 898	1 441	1 556	1 588	1 646	2 080	2 160	1 739	2 051
EXPORTS										
Canadian	32 827	31 009	34 112	28 097	28 313	31 746	33 992	34 459	36 182	34 179
TOTAL										
Canadian	70 882	67 332	70 986	67 311	67 447	74 531	76 338	76 591	78 228	75 319
Imported	15 740	12 713	13 299	12 469	9 845	9 563	10 428	11 380	13 688	17 706
Total demand	86 622	80 045	84 285	79 780	77 292	84 094	86 766	87 971	91 916	93 025

Sources: Natural Resources Canada; Statistics Canada.
– Nil.
Note: Numbers may not add to totals due to rounding.

Copper

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Copper prices weakened throughout 1998 and the first half of 1999 due principally to the combined effects of reduced demand in Southeast Asia and further increases in world copper production capacity. While cutbacks and closures in the industry, particularly in North America, and the prospect of improving Asian demand resulted in some improvement in prices in July 1999, the existence of elevated copper inventories combined with the addition of capacity from a number of large, low-cost mining projects continued to exert a negative influence on the market.

CANADIAN DEVELOPMENTS

In 1998, Canadian copper mine production (recoverable copper in concentrate plus SX-EW output) increased to 705 200 t from 657 900 t in 1997. Refined copper production totaled 562 500 t in 1998 compared to 560 400 t in 1997 (this includes refined copper from both primary and secondary material).

British Columbia

On May 15, 1999, Highland Valley Copper, owned jointly by Cominco Ltd., Teck Corp., Rio Algom Ltd. and Highmont Mining Co., suspended production for an indefinite period due to low copper prices. In the weeks prior to the closure, Highland Valley had attempted to obtain concessions on wage and power costs that would have reduced operating costs by US9¢/lb. Although Highland Valley Copper was reported to have reached an agreement with the provincial utility, B.C. Hydro, to tie electricity costs to the world price of copper, the company and the United Steelworkers of America (USW) were unable to agree on wage concessions. Highland Valley Copper and the USW were expected to resume discussions in mid-August 1999. At the time of the production suspension, Highland Valley Copper was involved in contract negotiations with the USW to replace a contract that expired on September 30, 1998.

According to press reports, Highland Valley Copper was one of the highest-cost producers in North America with an estimated cash cost of about US68¢/lb. During 1998, Highland Valley Copper produced 172 000 t of copper in concentrate.

During the summer of 1998, British Columbia's Job Protection Commission was able to arrange certain hydro and other concessions to permit continued operation of Imperial Metals Corporation's Mount Polley gold-copper mine.

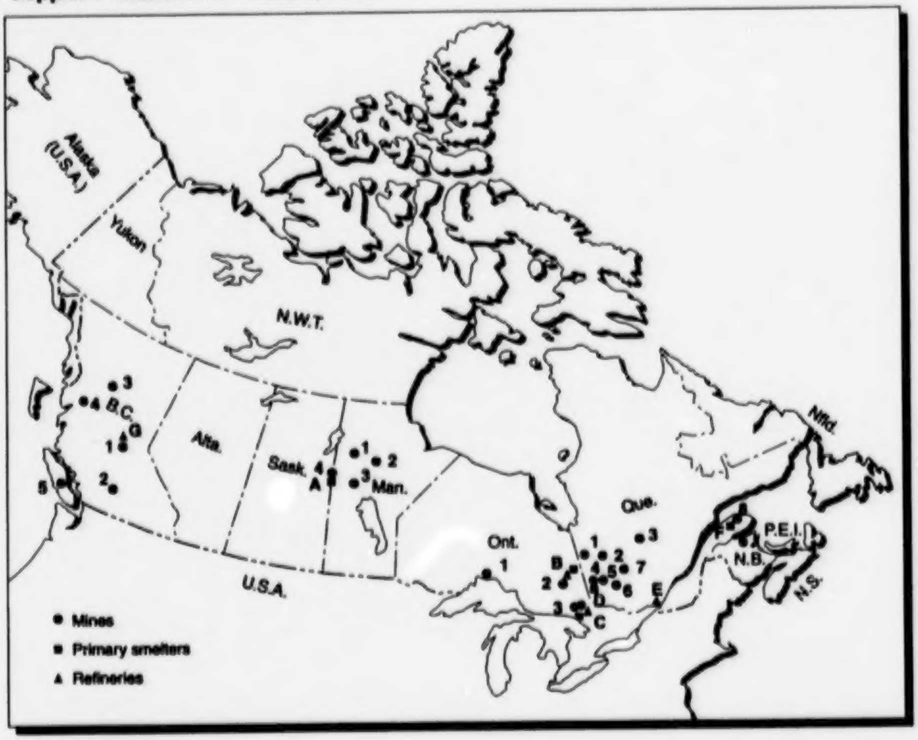
In May 1999, Imperial Metals announced that it had negotiated a second financial restructuring package for the Huckleberry mine with the four Japan Group companies (Mitsubishi Materials Corp., Marubeni Corp., Dowa Mining, and Furukawa Co.), which held a 40% interest in the mine. Upon approval by the Japan Group, the arrangement specifies the deferral of all principal and interest payments during 1999, while in 2000 and 2001 the payment of principal and interest will be dependent on available cash. In addition, smelter charges and payment terms will be improved. In consideration of these and other elements of support, Imperial agreed to sell an additional 10% interest in the Huckleberry mine to the Japan Group for a nominal amount.

In December 1998, Boliden Limited closed its Gibraltar mine citing low ore grades and low copper prices. In April 1999, Taseko Mines Limited announced that it had agreed to purchase the operation from Boliden. Taseko stated that it would maintain the mine on a standby care and maintenance basis until copper prices stabilized at a profitable level. In 1997, Gibraltar produced approximately 33 000 t of copper at a cash production cost of more than US$2000/t (US90¢/lb).

In mid-December 1998, Boliden Limited temporarily suspended production at its Myra Falls underground polymetallic mine on Vancouver Island in order to implement the action plan to address challenging ground conditions in the Battle zone of the mine. Due to the success of the rehabilitation and development program, Boliden restarted operations at Myra

Figure 1

Copper Producers in Canada, 1998



MINES

British Columbia
1. Boliden Limited (McLeese Lake)
2. Highland Valley Copper[1]
3. Royal Oak Mines Inc. (Kemess)
4. Imperial Metals Corporation (Huckleberry)
5. Boliden Limited (Myra Falls)
6. Imperial Metals Corporation (Mount Polley)

Saskatchewan
Hudson Bay Mining and Smelting Co., Limited (Flin Flon)

Manitoba
1. Hudson Bay Mining and Smelting Co., Limited (Ruttan mine)
2. Inco Limited (Thompson mine)
3. Hudson Bay Mining and Smelting Co., Limited (Photo Lake mine)
4. Hudson Bay Mining and Smelting Co., Limited (Flin Flon area mines including Konuto Lake)

Ontario
1. Inmet Mining Corporation (Winston Lake mine)
2. Falconbridge Limited (Timmins)
3. Falconbridge Limited (Sudbury area)
   Inco Limited (Sudbury area)

Quebec
1. Les Mines Selbaie
2. Noranda Inc. (Matagami Division)
3. Campbell Resources Inc.
4. Cambior Inc. (Bouchard-Hébert mine)
5. Agnico-Eagle Mines Limited (La Ronde mine)
   Barrick Gold Corporation (Bousquet mine)

Quebec (cont'd)
6. Aur Resources, Inc., Novicourt Inc., Teck Corporation (Louvicourt mine)
7. Cambior inc. (Gonzague Langlois mine)
8. Noranda Inc., Division Mines Gaspé
9. Falconbridge Limited (Raglin)

New Brunswick
Noranda Inc. (Heath Steele mine)
Noranda Inc. (Brunswick mine)

PRIMARY SMELTERS

A. Hudson Bay Mining and Smelting Co., Limited (Flin Flon)
B. Falconbridge Limited (Timmins)
C. Inco Limited (Sudbury area)
   Falconbridge Limited (Sudbury area)
D. Noranda Inc. (Noranda)
F. Noranda Inc. (Gaspé)

REFINERIES

B. Falconbridge Limited (Timmins)
C. Inco Limited (Sudbury area)
E. Noranda Inc. (CCR Division)
G. Gibraltar Mines Limited (SX-EW)

1 Highland Valley Copper is a partnership of Cominco Ltd., Teck Corporation and Rio Algom Limited.

Falls on March 24, 1999, eight days earlier than originally anticipated. In 1998, the Myra Falls mine produced 15 500 t of copper in concentrate.

In mid-April 1999, Royal Oak Mines Inc., the owner of the Kemess copper-gold mine, was forced into receivership after a lengthy struggle against the combined effects of low metal prices and a high debt load. At the time of writing, PricewaterhouseCoopers, the interim receiver for the company, was continuing to operate the mine. The Kemess mine reached commercial production levels in October 1998.

Manitoba/Saskatchewan

Hudson Bay Mining & Smelting Co. Limited (HBMS) reported that its Konuto Lake copper-zinc mine west of Flin Flon achieved commercial production levels in the second quarter of 1999. The mine is expected to produce 10 000 t/y of copper plus zinc for six years.

HBMS also announced plans to develop its new 777 deposit near Flin Flon with production expected to begin in 2003. Production from 777 will replace output from other mining operations in the area that are scheduled to close due to the exhaustion of ore reserves. The deposit is estimated to contain a resource of about 13.3 Mt grading 3.3% copper, 5.8% zinc, 2.7 g/t gold and 37.7 g/t silver.

Ontario

In 1998, Inco completed a comprehensive review of mining operations at its Ontario Division to identify opportunities to maximize cash flow, ensure efficient mining operations and lower mining costs. After closing its Shebandowan and Whistle mines in 1998, Inco Limited announced in July 1999 that its Levack/McCreedy West mine was closing immediately, several months ahead of schedule, while the company's Little Stobie mine would close in August. Inco also confirmed that its Crean Hill mine will close in 2000 while its Coleman mine will close in 2001.

As a result of weak metal markets, Inco announced in February 1999 that it would extend its annual vacation shut-down of the mines and concentrator at the Ontario Division by an additional two weeks to five weeks in order to align mine production with market requirements.

At the end of 1998, Inco reported that it had achieved permanent employment reductions of 1200 employees at the Ontario Division. The company reported that reductions were achieved, where possible, through retirement and attrition. Inco also announced that it expected to implement further employment reductions during 1999.

On November 25, 1998, Falconbridge Limited's Kidd Creek copper smelter in Timmins experienced a runout at its converting furnace. The company reported that the failure caused the loss of 9000 t of copper cathode.

On July 8, 1999, production and maintenance workers, represented by the Canadian Auto Workers' Union, began a legal strike at Falconbridge's Kidd metallurgical site after the two parties failed to agree on the terms of settlement for their first collective agreement. During the strike, which lasted until August 2, 1999, both the copper smelter and zinc plant were shut down, although the Kidd Creek mine continued to operate and stockpile its production.

In December 1998, Inmet Mining Corporation announced that it was permanently closing its Winston Lake mine after studies concluded that the operation was uneconomic. Winston Lake produced 9900 t of zinc and 500 t of copper in concentrate in 1998.

Quebec

In July 1999, Noranda Inc. reported that its $124 million permanent copper cathode project at the CCR refinery in Montréal-Est was 90% complete and was expected to be fully operational during the first quarter of 2000. The company expects that the project will increase productivity, reduce unit costs and improve the in-plant environment.

Also in July 1999, employees of Noranda's Horne copper smelter in Rouyn-Noranda, Quebec, voted 79% in favour of accepting the terms of a new three-year collective agreement. In 1998, the smelter processed approximately 830 000 t of concentrate and recyclable material containing copper, and produced more than 500 000 t of sulphuric acid.

In February 1999, Alcatel SA announced that it would close its Hochelaga cable manufacturing plant near Montréal in June 1999. The company stated that production at the plant would be transferred to a facility in Pennsylvania. The closure will result in the loss of 160 jobs.

Newfoundland and Labrador

On April 1, 1999, the Environmental Assessment Panel for the Voisey's Bay project in Labrador recommended that the development be authorized to proceed although it specified numerous conditions. These included the conclusion of an agreement between the Government of Newfoundland and Labrador and Voisey's Bay Nickel Company on the terms of a mining lease, the resolution of land claims with Aboriginal groups, and the negotiation of an impact and benefit agreement between the Aboriginal groups and the company.

In its August 3, 1999, response to the Environmental Assessment Panel Report, the Government of Canada concluded that the environmental effects of the mine/mill project would be acceptable as long as appropriate mitigative measures were put in place and appropriate monitoring and other follow-up programs are undertaken to ensure that these measures are being successfully implemented. In addition, the Government of Canada committed to negotiate consultation protocols with relevant Aboriginal groups, while the Government of Newfoundland and Labrador committed to develop a project-specific environmental management mechanism for involving affected Aboriginal groups.

On the basis of exploration and related work completed through to the end of June 30, 1999, Inco Limited reported that the total estimated resource for all zones or sections of the Voisey's Bay deposit had increased 10% to 136.7 Mt from the previously announced estimate of 124.4 Mt. The company also reported that the total resource, including proven and probable reserves of 32 Mt for the Ovoid section of Voisey's Bay, was still anticipated to be at least 150 Mt. It is expected that Voisey's Bay will produce up to 90 000 t/y of copper in concentrate.

World Developments

World mine production of copper was 12.17 Mt in 1998 compared to 11.54 Mt in 1997 (Table 3). During 1998, world production of refined copper (which includes refined copper from both primary and secondary material) increased to 13.96 Mt from 13.48 Mt in 1997 (Table 4). Due to low copper prices, which discouraged recovery and possibly encouraged hoarding, copper scrap supplies were extremely tight in 1998. Within the total world production of refined copper, the secondary component fell to 1.86 Mt in 1998 from 2.04 Mt in 1997. On the basis of statistics to May 1999, this downward trend continued into 1999.

Chile

According to Comisión Chilena del Cobre (Cochilco), Chilean copper mine production in 1999 was expected to increase by 16.2% to 4.3 Mt.

The Corporacion Nacional del Cobre de Chile (Codelco-Chile), the state-owned copper producer, announced that its new Radomiro Tomic mine near Chuquicamata would be expanded from 180 000 t/y to 250 000 t/y of copper cathode. Codelco-Chile expected that the US$220 million expansion would be operating at full capacity in the second half of 2001.

Codelco-Chile also announced that it was proceeding with its PDT expansion at its El Teniente Division, which will increase output to 500 000 t/y from about 350 000 t/y of copper. While the original project, which had been named Teniente 2000, was scheduled to be completed in 2000, Codelco stated that PDT would be completed at a somewhat slower pace.

Minera Escondida Limitada closed its Coloso copper anode plant at the end of May 1998 due to poor market conditions. The plant, which utilized an ammonia-based solvent extraction process, had been hampered by technical problems that prevented it from reaching its 80 000-t/y design capacity. While total copper production at Escondida was slightly lower in 1998 due to lower ore grades, the Phase 3.5 expansion and 125 000-t/y oxide project were completed in December. A Phase 4 expansion of the operation is also being considered as a means of maintaining production at about 800 000 t/y of copper given that ore grades are expected to decline.

Minera Los Pelambres, a joint venture between Antofagasta Holdings plc (Luksic Group), Nippon Mining & Metals Co. Ltd. and Mitsubishi Materials Corporation, expects to begin copper production at the Los Pelambres project in the fourth quarter of 1999. During the first 10 years of operation, the US$1.3 billion Los Pelambres mine is expected to produce an average of 246 000 t/y of copper in concentrate.

Equatorial Mining NL of Australia and Antofagasta Holdings plc plan to begin construction in late 1999 on the US$300 million El Tesoro copper project in northern Chile. This solvent extraction-electrowinning (SX-EW) operation, which would produce about 75 000 t/y over 18 years, is expected to begin production in 2001.

The US$1.76 billion Collahuasi copper mine in northern Chile was completed in the fourth quarter of 1998 and commercial production began in January 1999. Annual output at Collahuasi is expected to total 330 000 t of copper in concentrate and 50 000 t of copper cathode. The Collahuasi project is owned by Falconbridge (44%), Minorco SA (44%) and a consortium of Japanese companies (12%) that includes Mitsui and Co., Ltd., Nippon Mining & Metals, and Mitsui Mining & Smelting Co. Ltd.

In April 1999, Noranda Inc. reported that engineering and design were proceeding for the expansion at the Altonorte copper smelter in northern Chile, although the completion date had been deferred by 18 months to early 2003. The planned expansion will increase production by 130 000 t to 290 000 t/y of copper cathode.

Boliden Limited reported that its Lomas Bayas copper project began commercial production on September 1, 1998. The company expects that the operation will reach its full production level of 60 000 t/y in 1999. Boliden has estimated that the cash operating

costs for Lomas Bayas over the life of the mine will be US54¢/lb of copper.

Although Boliden had initiated a feasibility study on its nearby Fortuna de Cobré deposit, the company decided to postpone completion of this work given the current copper price and capital market environment. Fortuna de Cobré is estimated to contain a resource of 848 Mt grading 0.24% copper.

In the third quarter of 1998, Rio Algom Limited completed an expansion of its Cerro Colorado SX-EW operation that increased capacity from 60 000 t/y to 100 000 t/y.

In July 1999, Rio Algom announced that it had increased the in-pit resource at its wholly owned Spence deposit in northern Chile by 100 Mt, or 33%, to 400 Mt grading 1.0% copper. The company also announced that it had increased potential production to 227 000 t/y of copper, including 186 000 t/y of copper in concentrate and 41 000 t/y of copper cathode. Average cash costs were estimated at about US55¢/lb.

Rio Algom stated that the increases were based on prefeasibility work which indicated that a dual processing model, using both flotation and SX-EW, would allow the inclusion of an additional 100 Mt of sulphide ore at depth. Rio Algom estimates that total development costs would likely be in the range of US$1.0 billion. The company expects to complete a full feasibility study in 2000. Construction could begin in 2002 with the first production being recorded in 2004.

Peru

Southern Peru Copper Corporation (SPCC) completed a US$245 million expansion of its Cuajone mine in the first quarter of 1999 that increased capacity from 64 000 t/d to 96 000 t/d. SPCC expects to complete a US$875 million modernization and expansion of its Ilo smelter by 2003. This project includes the installation of a new single-line flash smelting furnace and a single-line converting furnace to process approximately 1.1 Mt/y of copper concentrate. The company expects that the new facility will have a sulphur capture rate in excess of 99%.

In July 1998, Rio Algom Limited, Noranda Inc. and Teck Corporation finalized arrangements to form a new ownership structure for the Antamina copper-zinc project in Peru that had been owned equally by Rio Algom and Inmet Mining Corporation. Antamina is estimated to contain an in-pit resource of 494 Mt grading 1.3% copper, 1.0% zinc, 12 g/t silver and 0.03% molybdenum.

As a result of the July transaction, Rio Algom retained 37.5% of Compania Minera Antamina (CMA) while Noranda and Teck obtained 37.5% and 25% interests respectively in CMA. In exchange for its 50% interest in the project, Inmet received $70 million and future payments from Noranda and Teck equivalent to 3.33% of free cash flow from the project.

In September 1998, Rio Algom, Noranda and Teck announced that they were proceeding with development of the project. At a planned milling rate of 70 000 t/d, Antamina will produce 272 000 t/y of copper and 160 000 t/y of zinc over a 20-year mine life. Development costs for the project are estimated at US$2.2 billion. Projected average cash costs per pound of copper, net of by-product credits, are estimated at US40¢.

On June 30, 1999, Rio Algom, Noranda and Teck announced that CMA had signed definitive documentation for US$1.32 billion in financing for the Antamina project. The partners also announced that a definitive agreement has been reached with Mitsubishi Corporation whereby Mitsubishi would acquire 10% of CMA, subject to the satisfaction of certain conditions, including closure of the project financing.

Following completion of the Mitsubishi transaction, CMA will be owned 33.75% by each of Rio Algom Limited and Noranda Inc., 22.5% by Teck Corporation and 10% by Mitsubishi Corporation. Antamina is expected to begin production in 2002.

In February 1998, Cambior announced that it was deferring its La Granja copper project due to low metal prices. The company expects that a 130 000-t/d operation would produce between 250 000 and 300 000 t/y of copper. Capital costs are estimated at $1.3 billion for a mine or $2.2 billion for a fully integrated mine and smelter/refinery. Mining reserves are estimated at 2.3 billion t grading 0.59% copper.

During 1998, the project was reengineered to allow development in phases, focusing first on open-pit mining and leaching/SX-EW operations on secondary mineralization of the deposit.

In 1999, Cambior planned to complete metallurgical studies on the alternative of copper production through leaching and SX-EW of the higher-grade portion of the secondary mineralization.

United States

On June 25, 1999, Broken Hill Proprietary Co. (BHP) announced that it would close certain of its U.S. copper operations by the end of August. This included about 190 000 t/y of sulphide mine capacity at its Robinson and San Manuel mine operations and the 340 000-t/y San Manuel smelter and refinery. In 1998, BHP closed its 70 000-t/y Pinto Valley sulphide operation.

On June 30, 1999, Phelps Dodge Corporation announced that during the third quarter of 1999, the company would temporarily close its Hidalgo smelter and the smaller of two concentrators at its Morenci, Arizona, mining complex. The company expected that the production curtailment would result in an average reduction of approximately 68 000 t/y of total copper production. Phelps Dodge stated that it would retain its ability to smelt substantially all of its U.S. copper concentrates internally at its Chino smelter in New Mexico and continue to produce most of the acid consumed by its mining operations. The company also stated that production at the company's copper refinery in El Paso, Texas, would be curtailed by approximately 50%.

In July 1999, Asarco Inc. announced that it would reduce production at its Mission mine by about 25 000 t/y.

Also in July 1999, Cyprus Amax Minerals Company and Asarco Incorporated announced an agreement for the combination of the two companies in a merger-of-equals transaction. The two companies stated that the combined company, to be known as Asarco Cyprus Incorporated, would reduce the combined expenses of Cyprus Amax and Asarco by approximately US$150 million annually. Cyprus Amax and Asarco also stated that when the expense reductions are fully implemented by 2001, the new company's cash cost of producing copper will be approximately US50¢/lb. The combined company will have an annual copper production of approximately 900 000 t.

Australia

The joint-venture company Port Kembla Copper, which is owned 52.5% by Furukawa Co. Ltd., 20% by Nittetsu Mining Co. Ltd., 17.5% by Nissho Iwai Corporation and 10% by Itochu Corp., was expected to complete a modernization and expansion of its Port Kembla copper smelter in the third quarter of 1999. The smelter was idled by its previous owners in January 1995.

Western Mining Corporation reported its expectation that the expansion of its Olympic Dam copper-uranium mine and copper smelter to 200 000 t/y of refined copper would be completed in the second half of 1999.

Indonesia

P.T. Freeport Indonesia Company (PTFI), owned by Freeport-McMoRan Copper & Gold Inc. and Rio Tinto plc, reported that, at the end of 1998, its proven and probable reserves at its copper-gold operations in Irian Jaya totaled 2.475 billion t grading 1.13% copper, 1.06 g/t gold and 3.8 g/t silver. For the second quarter of 1999, PTFI reported that its average unit production costs, including gold and silver credits, were US11¢/lb.

Production at the new 200 000-t/y copper smelter/refinery at Gresik in East Java began at the end of 1998 and is expected to reach full design capacity in the second half of 2000. This facility is owned by Mitsubishi Materials Corporation (75%) and Freeport-McMoRan (25%).

In July 1999, Newmont Mining Corporation announced that its 45%-owned Batu Hijau project was more than 95% complete and was expected to begin production in the fourth quarter of 1999. Sumitomo Corporation holds 35% of the project while P.T. Pukuafu Indah holds the remaining 20% interest.

Batu Hijau is expected to produce an average of about 270 000 t/y of copper and 14 900 kg/y of gold over the first five years of the mine life. Anticipated total cash costs for the project are estimated at US48¢/lb of copper after gold credits.

Thailand

Thai Copper Industries Public Company Limited announced in March 1999 that it had delayed the start-up of its new 165 000-t/y smelter/refinery complex until the first quarter of 2001. The company reported that the project was about 70% completed.

Myanmar

Ivanhoe Mines Ltd. reported that its 50%-owned S&K SX-EW copper operation began production in November 1998. The company also announced that it will proceed with an expansion of the operation from 25 000 t/y to 35 000 t/y of copper cathode.

Sweden

Boliden Limited expects to complete a 100 000-t/y expansion to its Rönnskär smelter and refinery to 240 000 t/y of copper cathode by mid-2000. The US$245 million project includes a new flash furnace, three new converters, a new anode casting plant, and expansion of the tankhouse and sulphuric acid plant.

France

In November 1998, Cie Générale d'Eléctrolyse du Palais announced that it would close its copper refinery in Haute Vienne by the end of February 1999.

Zambia

Under the terms of a Memorandum of Understanding signed by the Government of Zambia, Zambia Consolidated Copper Mines Limited (ZCCM) and Anglo American plc on January 21, 1999, Anglo agreed to

pay US$90 million in cash and $300 million in future capital investments for ZCCM's Nkana, Nchanga and Konkola divisions and the Nampundwe mine.

In March, Anglo reported that certain of the pre-conditions for the finalization of the transaction, notably the identification of a substantial mining partner for Anglo, had not yet been satisfied, due partially to depressed metal prices.

In February 1999, ZCCM announced that it would retrench over 7000 workers as part of a major restructuring initiative that resulted from an agreement reached between ZCCM, the Zambian government and the World Bank to create a manageable work force prior to the privatization of some of the company's major productive assets.

In early 1999, the Binani Group, through Roan Antelope Mining Company, announced that it had finalized investment plans for its Muliashi North project, the refurbishment of a copper smelter, and construction of a new acid plant. Over the next two years the company expects to increase copper production from 45 000 t/y to 65 000 t/y.

Roan Antelope also announced that it was proceeding with development of the Muliashi North copper project. The operation, which will produce about 34 000 t/y of copper, is expected to begin production in September 2000.

Democratic Republic of the Congo

In February 1999, Tenke Mining Corp. declared force majeure at its $475 million copper-cobalt Tenke Fungurume project. The company stated that it had taken this action after its plans to complete a feasibility study on its 55%-owned project had been undermined by six months of fighting between government troops and rebels. The Congo's state-owned mining firm, Gecamines, held the remaining 45% stake in Fungurume.

In April 1999, the shareholders of Tenke Mining approved an arrangement to grant BHP Copper Inc. an option to acquire a 45% ownership interest in the Tenke Fungurume concession.

The Tenke Fungurume deposit contains an estimated resource of 500 Mt grading 3.5% copper and 0.27% cobalt. The project is forecast to produce 100 000 t/y of copper for the first four years of operation, climbing to 200 000 t in the fifth year. Cobalt output is estimated at 6000 t/y, rising to 13 000 t. Capital costs for the project are estimated at US$475 million.

Consumption and Uses

World copper consumption increased to 13.4 Mt in 1998 from 13.1 Mt in 1997 (this includes refined copper from both primary and secondary material). Canadian refined copper consumption increased to 246 200 t in 1998 from 224 600 t in 1997.

It is estimated that over 3.2 Mt of copper scrap was used directly by consumers worldwide in 1998. According to an annual survey conducted by Natural Resources Canada, 38 100 t of contained copper in scrap was consumed directly by Canadian manufacturers in 1997.

Table 8 presents preliminary end-use data for 1997 and 1998 for the United States collected by the Copper Development Association Inc. (detailed copper consumption statistics are not officially collected in Canada).

Markets

In Canada, copper tube and fittings are now being used in houses and other buildings to carry natural gas. The growth of this market has been dramatic with copper quickly becoming the preferred material, replacing steel pipe. This market is being heavily promoted by the Canadian Copper and Brass Development Association (CCBDA) with the financial support of the ICA. The CCBDA will make special promotional efforts in areas of eastern Canada that have recently gained, or will soon gain, access to natural gas distribution. The CCBDA and the Copper Development Association Inc. of the United States have also jointly undertaken major North American initiatives on the promotion of copper plumbing tube and fittings as well as architectural applications.

The CCBDA is also actively involved in the promotion of electrical wire and cable, with particular emphasis on the use of larger conductors to improve energy efficiency and power quality, and on industrial and commercial power cable for building applications.

In recent years, copper has benefited from increasing consumer demand for large and small appliances, household convenience items, computers, and automotive options. In North America, there has been a noticeable increase in the intensity of copper use in residential applications. Part of this change is attributable to the construction of larger houses and the growth of home-based offices. In many homes there is a need for multiple phone lines to handle faxes, modems and security systems.

Although the use of fibre-optic cable in the communications and telecommunications sectors has increased in recent years, the development of new technologies has permitted copper wire to remain competitive, particularly in low-density applications, including communication connections to individual homes and for internal network links such as desk-to-desk telephone and computer connections. According to a

recent press report, the market for short cables, which are used to interconnect telephones, computers and other electronic devices, has experienced double-digit growth rates for several years in the North American, European and Asian markets.

The use of additional electronics has stimulated growth in demand for copper wire from the automotive industry in recent years. However, the introduction of multiplex electronic systems could limit copper demand in this application.

Aluminum has largely replaced copper in the original-equipment automotive radiator market, particularly in the United States. However, the ICA has reported that copper still accounts for about two thirds of the global radiator market. According to the ICA, copper is particularly dominant in heavy-duty applications and in the after-market where the metal has an 80% market share. The ICA estimates that worldwide copper usage for radiators is about 190 000 t/y.

With technological advances and design innovations, new brazed copper-brass radiators have been developed that are 35-40% lower in weight than traditional copper-brass radiators. According to the ICA, these brazed radiators are produced more easily and at a lower cost than comparable aluminum radiators.

A number of other promising new markets for copper could also provide significant growth opportunities. These include the use of copper as an additive in roofing shingles to prevent the formation of algae and fungus, as well as use in fire suppression systems, natural gas systems, solar power generation equipment, and the storage of spent nuclear fuel.

HEALTH

Although copper toxicity is recognized at elevated intake/exposure levels, the element is an essential nutrient for human health. At a Task Group meeting of the International Programme on Chemical Safety (IPCS) held in Brisbane in June 1996, there was a recognition that copper is an essential trace element for human health and that there are greater risks, in Europe and the Americas in particular, of health effects from copper deficiency than from excess copper intake.

The U.S. National Academy of Sciences/National Research Council has recommended a daily intake of 0.4-0.6 mg for children up to six months of age, increasing progressively to 1-2 mg for children up to 10 years of age. For adolescents and adults, the recommended range is 1.5-2.5 mg and 1.5-3.0 mg, respectively. The World Health Organization (WHO) has suggested a recommended daily intake of copper of 80 micrograms per kg for infants and young children, and 40 and 30 micrograms per kg for older children and adult males, respectively.

Acute copper poisoning is infrequent in humans and is largely restricted to the voluntary or accidental ingestion of copper salts. According to the Copper Development Association Inc., the WHO and the U.S. Food and Agricultural Administration (FAA) are likely to suggest that the population's mean intake of copper should not exceed 12 mg/d for adult males and 10 mg/d for adult females. These levels are regarded as the lowest intake levels likely to produce the slightest biochemical evidence of undesirable effects in all but a small number of the population.

Many regulatory agencies, including Health Canada, have chosen 1 part per million (ppm) as the maximum desirable concentration of copper in drinking water. It signifies more of an aesthetic limit than a health limit; water containing more than 1 ppm can stain laundry, and persons with a keen sense of taste may perceive a metallic flavour in the water.

In 1993, the WHO included copper in a group of chemicals of health significance in drinking water and recommended a guideline value of 2 mg/L. The recommendation was deemed provisional due to uncertainties regarding copper toxicity in humans. As a result, scientific discussions were conducted internationally, and the WHO revised its recommendation in 1997 with the guideline value of 2 mg/L for copper now defined on the basis of the potential for acute gastrointestinal effects. The recommendation remains provisional given the remaining uncertainties regarding copper toxicity in humans.

STOCKS

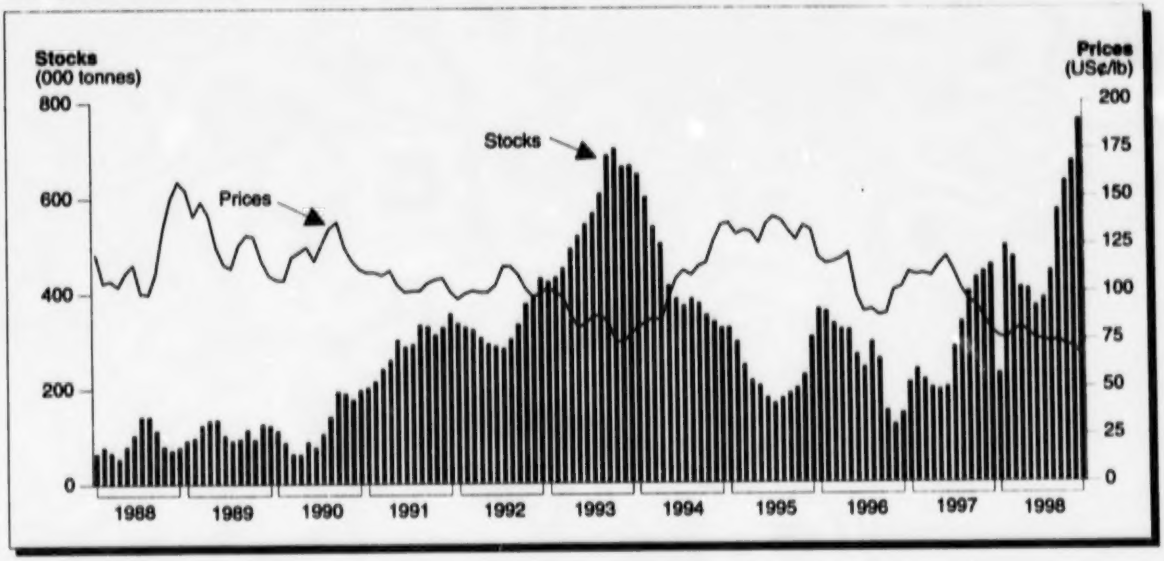
Combined copper stocks on the London Metal Exchange (LME), the Commodities Exchange, Inc. (COMEX) and the Shanghai Metal Exchange increased throughout 1998 to reach 760 000 t at the end of December. At the end of December 1997, stocks stood at 457 500 t.

At the end of 1998, total copper stocks, including those at producers, merchants, consumers and exchanges, totaled 1 349 800 t compared to 1 010 200 t at the end of 1997. Figure 2 shows both total copper stocks and prices for the period 1988-98.

PRICES

Copper prices on the London Metal Exchange (LME) averaged US$1654/t ($0.75/lb) in 1998 (Figure 2) compared to US$2276/t ($1.03/lb) in 1997. The average copper price in 1999 to the end of July was US$1466/t ($0.66/lb).

Figure 2
Copper Prices[1] and Exchange[2] Stocks, 1988-98



Source: Natural Resources Canada.
[1] Average monthly LME cash prices. [2] Combined exchange stocks at end of the month.

In 1998 and the first half of 1999, Canadian producers sold refined copper in the United States at COMEX (high grade first position close) plus a premium of US3.3¢/lb, while in Canada prices were set at the Canadian dollar equivalent of COMEX plus 4.5¢-5.0¢/lb. For sales in Europe, Canadian producers established a price of LME (Grade A Settlement Price) plus an average premium of US$30-$35/t in 1998 and US$38/t in 1999.

Treatment and Refining Charges

Benchmark smelting and refining charges for 1999 were established at US$66/dry metric tonne (dmt) and US6.7¢/lb. In May 1999, spot smelting and refining charges were reported to be as low as US$25/dmt and 2.5¢/lb.

Benchmark charges in 1998 were US$99/dmt and 9.9/lb, while in 1997 the benchmark was roughly US$105/dmt and 10.5¢/lb.

Outlook

With strengthening copper demand in Asian markets and some further cutbacks in copper production, copper prices are expected to strengthen in the second half of 1999 and to continue to improve in 2000.

With the improvement in copper prices in the second half of 1999, it is expected that the copper price for the year will average about US$1550/t. In 2000, copper is expected to trade within a range of US$1600 and $1800/t while, in the longer term, copper prices are expected to trade in a range between $1900 and $2200/t (in constant 1997 dollars).

As a result of strong growth in copper demand in Asia, world consumption of refined copper in 1999 is expected to increase to about 13.8 Mt from 13.4 Mt in 1998. In 2000, it is expected to increase to about 14.2 Mt. It is expected that copper consumption in the longer term will grow at an annual average rate in excess of 3.5%. A significant proportion of this growth is expected to be in China. According to a press report, Simon Hunt (Strategic Services) Ltd. expects that refined copper consumption in China will grow at an annual average rate of 9% to 2005 and even faster during the three following years.

Canadian copper mine production (recoverable copper in concentrate) in 1999 had been expected to increase to over 700 000 t. However, the temporary closure of Highland Valley Copper will result in an overall reduction of mine production to about 600 000 t. In 2000, a further reduction is possible given that the incremental production from the new Minto mine in the Yukon and the Bell Allard mine in Quebec is likely to be exceeded by the loss of production associated with the permanent closure in the second half of

1999 of the Gaspé mine in Quebec and the Heath Steele mine in New Brunswick.

During 1999, Canadian refined copper production is forecast to be 585 000 t compared to 562 500 t in 1998 (includes refined copper from both primary and secondary material). Depending on feedstock availability, refined output in 2000 could increase to 625 000 t.

Canadian refined copper consumption is expected to increase by 4.2% to 255 000 t in 1999 and by a further 1.2% to 258 000 t in 2000. These increases are expected to result from continued strong demand for data and telephone cables and from increased exports of copper wire (rod), particularly to the United States.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of August 15, 1999.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EU MFN	Japan[1] WTO
2603.00	Copper ores and concentrates						
2603.00.00.10	Copper content	Free	Free	Free	Free	Free	Free
2825.50	Copper oxides and hydroxides	Free	Free	Free	Free	3.2%	5%
28.33	Sulphates; alums; peroxosulphates (persulphates)						
	Other sulphates:						
2833.25	Of copper						
2833.25.10	Cupric sulphate	Free	Free	Free	Free	3.2%	4.2%
2833.25.90	Other copper sulphates	5.5%	Free	Free	Free	3.2%	4.2%
74.01	Copper mattes; cement copper (precipitated copper)						
7401.10	Copper mattes	Free	Free	Free	Free	Free	Free
7401.20	Cement copper (precipitated copper)	Free	Free	Free	Free	Free	Free
7402.00	Unrefined copper; copper anodes for electrolytic refining	Free	Free	Free	Free	Free	3.9%
74.03	Refined copper and copper alloys, unwrought						
	Refined copper:						
7403.11	Cathodes and sections of cathodes	Free	Free	Free	Free	Free	4.20-11.96 yen/kg
7403.12	Wire bars	Free	Free	Free	Free	Free	4.20-11.96 yen/kg
7403.13	Billets	Free	Free	Free	Free	Free	4.20-11.96 yen/kg
7403.19	Other	Free	Free	Free	Free	Free	4.20-11.96 yen/kg
	Copper alloys:						
7403.21	Copper-zinc base alloys (brass)	Free	Free	Free	Free	Free	4.20 yen/kg
7403.22	Copper-tin base alloys (bronze)	Free	Free	Free	Free	Free	4.20-11.96 yen/kg
7403.23	Copper-nickel base alloys (cupro-nickel) or copper-nickel-zinc base alloys (nickel-silver)	Free	Free	Free	Free	Free	4.20-11.96 yen/kg
7403.29	Other copper alloys (other than master alloys of heading no. 74.05)	Free	Free	Free	Free	Free	4.20-11.96 yen/kg
7404.00	Copper waste and scrap	Free	Free	Free	Free	Free	Free
7405.00	Master alloys of copper	Free	Free	Free	Free	Free	3.6%
74.06	Copper powders and flakes	Free	Free	Free	Free	0.3-1.2%	3.8%
74.07	Copper bars, rods and profiles	Free-3%	Free	Free	Free	5%	3.6-3.8%
74.08	Copper wire, of refined copper	Free-3%	Free	Free	Free	5%	3.6-3.8%
74.09	Copper plates, sheets and strip, of a thickness exceeding 0.15 mm	Free	Free	Free	Free	5%	3.6-3.7%
74.10	Copper foil (whether or not printed or backed with paper, paperboard, plastics or similar backing materials) of a thickness (excluding any backing) not exceeding 0.15 mm	Free	Free	Free	Free	5.5%	3.6-3.7%
74.11	Copper tubes and pipes	2-2.5%	Free	Free	Free	5%	3.7-4%
74.12	Copper tube or pipe fittings (for example, couplings, elbows, sleeves)	3%	Free	Free	Free	5.5%	1.2%
7413.00	Stranded wire, cables, plaited bands and the like, of copper, not electrically insulated	3%	Free	Free	Free	5.5%	3.8%

TARIFFS (cont'd)

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EU MFN	Japan[1] WTO
7413.00	Stranded wire, cables, plaited bands and the like, of copper, not electrically insulated	3%	Free	Free	Free	5.5%	3.8%
74.14	Cloth (including endless bands), grill and netting, of copper wire; expanded metal of copper	3%	Free	Free	Free	4.7%	1-1.2%
74.15	Nails, tacks, drawing pins, staples (other than those of heading no. 83.05) and similar articles, of copper or of iron or steel with heads of copper; screws, bolts, nuts, screw hooks, rivets, cotters, cotter-pins, washers (including spring washers) and similar articles, of copper	Free-3%	Free	Free	Free	3.4-4.5%	1.2%
7416.00	Copper springs	3%	Free	Free	Free	4%	1.2%
7417.00	Cooking or heating apparatus of a kind used for domestic purposes, non-electric and parts thereof, of copper	3%	Free	Free	Free	4.5%	1.2%
74.18	Table, kitchen or other household articles and parts thereof, of copper; pot scourers and scouring or polishing pads, gloves and the like, of copper; sanitary ware and parts thereof, of copper	3%	Free	Free	Free	3.5%	1%
74.19	Other articles of copper	Free-9.5%	Free-5%	Free	Free	3.4%	1.2-2%

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States 1999; Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of the European Union (38th Annual Edition: 1998); Custom Tariff Schedules of Japan, 1998.
[1] WTO rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADA, COPPER PRODUCTION AND TRADE, 1997 AND 1998

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
SHIPMENTS[1]					
	Newfoundland	662	2 097	–	–
	Prince Edward Island	–	–	–	–
	Nova Scotia	–	–	–	–
	New Brunswick	13 627	43 144	14 553	35 786
	Quebec	125 396	397 0045	121 860	299 654
	Ontario	235 750	746 385	224 883	552 987
	Manitoba	52 216	165 317	50 203	123 449
	Saskatchewan	–	–	–	–
	Alberta	–	–	–	–
	British Columbia	220 127	696 922	277 078	681 334
	Yukon	–	–	–	–
	Northwest Territories	–	–	–	–
	Total	647 779	2 050 869	688 576	1 693 209
	Refinery output	560 582	. .	565 081	. .
EXPORTS					
2603.00.10	Copper ores and concentrates				
	Copper content				
	Japan	311 246	364 526	254 234	204 121
	South Korea	46 943	45 918	33 639	23 149
	Philippines	55 296	50 963	30 561	19 557
	China	66 668	68 262	15 868	17 407
	Mexico	10 499	10 974	11 781	10 192
	United States	. .	8	1 533	3 896
	Other countries	1 882	3 713	–	–
	Total	492 534	544 364	347 636	278 324
2604.00.00.10, 2607.00.00.10, 2608.00.00.10, 2616.10.00.10	Other ores and concentrates				
	Copper content				
	South Korea	3 507	4 129	–	–
	France	481	584	–	–
	Belgium	1 842	2 346	–	–
	United States	2	3	–	–
	Total	5 832	7 062	–	–

TABLE 1 (cont'd)

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
2620.30	Copper ash and residues				
	United States	227	396	140	164
	Total	227	396	140	164
2825.50	Copper oxides and hydroxides				
	United States	5	4	–	–
	Total	5	4	–	–
2833.25	Copper sulphates				
	United States	3 421	4 794	5 491	7 919
	China	20	27	–	–
	Total	3 441	4 821	5 491	7 919
7401.10	Copper mattes				
	Norway	16 073	48 619	17 104	38 954
	United Kingdom	1 108	3 553	1 260	3 230
	Total	17 181	52 172	18 364	42 184
7402.00	Copper anodes				
	United States	74 848	304 440	83 191	365 167
	Other countries	16	39	20	57
	Total	74 864	304 479	83 211	365 224
7403.11 to 7403.19	Refined copper and copper alloys, unwrought				
	United States	284 863	936 053	264 723	682 631
	United Kingdom	48 104	118 218	42 925	90 500
	Colombia	15 400	64 447	15 566	60 761
	France	12 731	40 607	9 552	24 253
	Italy	3 527	11 217	7 700	19 472
	Sweden	3 783	11 634	4 784	13 700
	Saudi Arabia	5 799	18 811	3 500	9 442
	Taiwan	4 752	13 307	2 566	6 358
	Other countries	2 517	9 481	3 650	13 447
	Total	381 476	1 223 775	354 966	929 564
7403.21 to 7403.29	Other copper alloys				
	United States	395	1 431	842	2 483
	China	–	–	22	162
	Total	395	1 431	864	2 645
7404.00	Copper waste and scrap				
	United States	111 191	263 597	86 714	192 891
	China	1 065	1 297	3 682	3 664
	Belgium	1 174	578	3 707	3 602
	Hong Kong	3 858	6 005	1 514	2 356
	Italy	376	675	1 197	1 999
	India	2 855	4 258	1 317	1 624
	Other countries	5 057	5 863	2 906	4 784
	Total	125 576	282 273	101 037	210 920
7405.00	Master alloys of copper				
	China	–	–	20	216
	United States	340	513	61	62
	Total	340	513	81	278
7406.10, 7406.20	Copper powders and flakes				
	United States	313	1 674	132	863
	Taiwan	62	588	20	233
	Other countries	44	385	34	290
	Total	419	2 647	186	1 386

TABLE 1 (cont'd)

Item No.		1997 (tonnes)	1997 ($000)	1998p (tonnes)	1998p ($000)
EXPORTS (cont'd)					
7408.11 to 7408.29	Copper and copper alloy wire				
	United States	51 621	177 381	72 532	203 303
	Chile	–	–	21	92
	Taiwan	–	–	20	83
	South Korea	–	–	3	53
	Hong Kong	1	23	5	47
	Other countries	54	215	40	135
	Total	51 676	177 619	72 621	203 713
7409.11 to 7410.22	Copper and copper alloy plates, sheets, strip and foil				
	United States	10 370	56 988	15 593	69 722
	Saudi Arabia	1 187	5 618	1 178	5 025
	India	283	1 314	593	2 442
	United Kingdom	568	2 269	609	2 121
	Algeria	118	590	332	1 302
	Other countries	1 172	6 261	1 869	7 810
	Total	13 698	73 040	20 174	88 422
7411.10 to 7411.29	Copper and copper alloy tubes and pipes				
	United States	17 196	101 065	16 928	88 780
	Netherlands	29	210	241	1 660
	Chile	86	501	279	1 129
	Israel	435	1 990	198	823
	United Kingdom	15	126	68	462
	Saudi Arabia	4	25	16	129
	Russia	...	3	15	96
	Other countries	137	626	31	185
	Total	17 902	104 546	17 776	93 264
7412.10, 7412.20	Copper and copper alloy tube and pipe fittings				
	United States	..	16 500	..	18 424
	Germany	..	5 610	..	9 293
	Spain	..	3 935	..	5 708
	United Kingdom	..	3 048	..	2 122
	Greece	..	585	..	1 228
	Sweden	..	1 425	..	1 204
	Poland	..	296	..	1 075
	France	..	1 463	..	858
	Other countries	..	2 300	..	507
	Total	..	35 162	..	40 419
7413.00	Stranded wire, cables, plaited bands and the like, of copper, not electrically insulated				
	United States	114	518	1 044	3 499
	Other countries	7	42	19	165
	Total	121	560	1 063	3 664
7414, 7415, 7416, 7419	Copper, other items of				
	United States	..	25 881	..	29 221
	United Kingdom	..	5	..	385
	Russia	..	88	..	297
	Other countries	..	4 362	..	1 418
	Total	..	30 336	..	31 321
	Total exports		2 892 199		2 348 447

TABLE 1 (cont'd)

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS[2]					
2603.00.00.10	Copper ores and concentrates				
	Copper content				
	United States	81 567	136 258	33 755	71 905
	Chile	12 702	31 480	45 121	60 025
	Indonesia	3 273	14 708	10 535	20 466
	Portugal	10 886	24 606	7 717	15 154
	Argentina	. . .	. . .	7 007	15 150
	Spain	1 128	1 657	5 157	9 956
	Switzerland	6 183	13 570	4 557	8 280
	Other countries	19 114	27 201	9 802	20 680
	Total	134 853	249 480	123 651	221 616
2604.00.00.10, 2607.00.00.10, 2608.00.00.10, 2616.10.00.10	Other ores and concentrates				
	Copper content				
	United States	910	1 401	628	987
	Mexico	132	347	108	236
	Russia	–	–	7	17
	Peru	4	11	1	3
	Total	1 046	1 759	744	1 243
2620.30	Copper ash and residues				
	United States	22 954	39 499	12 005	23 567
	Other countries	9 367	8 168	68 108	58 557
	Total	32 321	47 667	80 113	82 124
2825.50	Copper oxides and hydroxides	1 654	5 105	1 439	4 744
2833.25	Copper sulphates	12 605	13 139	15 247	13 332
2836.99.90.10	Copper carbonates	5	11	7	15
2837.19.00.10	Copper cyanides	37	233	42	257
3212.90.00.12	Pigments based on copper or copper alloy powders and flakes	15	126	n.a.	n.a.
3212.90.90.12	Pigments based on copper or copper alloy powders and flakes	n.a.	n.a.	3	54
7401.10	Copper mattes	8 802	22 039	2 596	9 0089
7401.20	Copper mattes; cement copper (precipitated copper)	409	1 706	8 103	15 973
7402.00	Copper anodes	27 341	83 436	19 528	36 209
7403.11 to 7403.19	Refined copper and copper alloys, unwrought				
	Refined copper				
	Total	22 602	71 166	18 685	47 994
7403.21 to 7403.29	Refined copper and copper alloys, unwrought				
	Other copper alloys				
	Total	6 738	21 549	7 190	19 545
7404.00	Waste and scrap, copper or copper alloy				
	United States	160 317	313 378	109 773	161 766
	Bulgaria	1 974	7 322	983	2 750
	Mexico	9	8	361	890
	United Kingdom	37	138	346	809
	Russia	5 542	5 132	657	656
	Other countries	5 826	17 408	910	1 256
	Total	173 705	343 386	113 030	168 127
7405.00	Master alloys of copper	104	444	361	1 359

TABLE 1 (cont'd)

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)					
7406.10, 7406.20	Copper powders and flakes				
	Total	1 554	8 513	1 704	9 113
7407.10 to 7407.29	Bars, rods and profiles of refined copper				
	United States	31 644	113 095	33 802	115 398
	Turkey	2 407	6 854	3 710	5 805
	Poland	3 292	7 575	2 274	4 956
	United Kingdom	198	987	378	1 499
	Germany	333	1 521	304	1 312
	France	278	990	370	1 285
	Other countries	937	3 701	1 179	4 210
	Total	39 089	134 723	42 017	134 465
7408.11 to 7408.29	Copper and copper alloy wire				
	Total	25 552	96 877	21 891	67 382
7409.11 to 7409.90, 7410.11 to 7410.22	Copper and copper alloy plates, sheets, strip and foil				
	Total	31 830	188 990	46 040	243 687
7411.10	Pipes and tubes, refined copper	8 725	39 193	9 066	37 518
7411.21	Pipes and tubes, copper-zinc base alloy	3 765	23 563	3 749	22 318
7411.22	Pipes and tubes, copper-nickel base alloy or copper-nickel-zinc base alloy	444	3 339	483	3 670
7411.29	Plates and tubes, copper alloy, n.e.s.	1 137	6 129	1 100	5 612
7412.10	Fittings, pipe or tube, of refined copper	386	6 490	309	5 665
7412.20	Fittings, pipe or tube, copper alloy	3 910	53 986	4 564	63 002
7413.00	Stranded wire, cable, plaited bands and the like, of copper, not electrically insulated	3 746	18 100	4 004	13 520
7414.90	Cloth, grill and netting of copper wire and expanded metal of copper	113	442	273	1 416
7415.10	Nails, tacks, drawing pins, staples and similar articles of copper or of iron or steel with copper heads	91	598	128	845
7415.21	Washers, copper, including spring washers	303	1 836	385	2 382
7415.29	Articles of copper, not threaded, n.e.s., similar to those of headings 7415.10 and 7415.21	299	1 637	433	2 127
7415.31	Screws, copper, for wood	155	302	39	245
7415.32	Screws, bolts and nuts of copper, excluding wood screws	963	4 434	. .	4 738
7415.39	Articles of copper, threaded, n.e.s., similar to bolts, nuts and screws	798	4 234	746	4 255
7416.00	Copper springs	. .	397	. .	176
7419.10	Chain and parts thereof of copper	124	923	82	537
7419.91	Articles of copper, not further worked than cast, moulded, stamped or forged	1 761	14 950	2 118	18 203
7419.99	Articles of copper, n.e.s.	. .	37 619	. .	45 999

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available or not applicable; . . . Amount too small to be expressed; n.a. Not applicable; n.e.s. Not elsewhere specified; p Preliminary.
1 Anode copper recovered in Canada from domestic concentrates plus exports of payable copper in concentrate and matte.
2 Imports from "other countries" may include re-imports from Canada.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, COPPER PRODUCTION, TRADE[1] AND CONSUMPTION, 1975, 1980 AND 1985-98

	Production		Exports				
	Shipments[2]	Refinery Output	Concentrates and Matte	Refined	Total	Imports Refined	Consumption[3] Refined
				(tonnes)			
1975	733 826	529 197	314 518	320 705	635 223	10 908	196 106
1980	716 363	505 238	286 076	335 022	621 098	13 466	208 590
1985	738 637	499 626	320 619	280 033	600 652	19 131	222 466
1986	698 527	493 445	341 390	306 822	648 212	20 901	225 586
1987	794 149	491 124	381 126	288 800	669 926	16 583	231 288
1988	758 478	528 723	348 404	268 680	617 084	4 659	236 280
1989	704 432	515 216	348 739	321 690	670 429	4 408	213 046
1990	771 433	515 835	374 875	335 941	710 816	2 611	180 605
1991	780 362	538 339	348 080	377 985	726 065	2 321	159 170
1992	761 694	539 302	346 842	385 761	732 603	8 916	156 132
1993	709 650	561 580	319 840	408 364	728 204	21 155	185 565
1994	590 784	549 869	237 554	388 568	626 122	19 594r	199 350r
1995	700 843	572 616	274 493r	409 361	683 854r	24 176r	189 550r
1996	652 499	559 200	409 577	384 338	793 915	28 700	218 280
1997	647 779	560 582	515 547	381 476	897 023	22 002	224 777
1998p	688 576	565 081	366 000	354 966	720 966	18 685	243 100

Sources: Natural Resources Canada; Statistics Canada.
p Preliminary; r Revised.
1 Beginning in 1988, exports and imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. 2 From 1975 to 1988, anode copper recovered in Canada from domestic concentrate plus exports of payable copper in concentrates and matte. Starting in 1989 to date, recoverable copper in concentrate shipped. 3 Producers' domestic shipments of refined copper plus imports of refined shapes.

TABLE 3. WORLD MINE PRODUCTION OF COPPER, 1996, 1997 AND 1998

	1996	1997	1998p
		(000 t)	
Australia	547	560	604
Canada	688	658	705
Chile	3 116	3 392	3 687
China	439	496	458
Indonesia	526	548	809
Kazakstan	250	316	338
Mexico	341	391	385
Papua New Guinea	186	112	152
Peru	484	503	483
Poland	422	415	427
Russia	523	505	500
South Africa	188	186	188
United States	1 953	1 979	1 900
Zambia	334	353	320
Other	1 105	1 128	1 224
Total	11 102	11 542	12 180

Source: International Copper Study Group.
p Preliminary.

TABLE 4. WORLD REFINERY PRODUCTION OF COPPER, 1996, 1997 AND 1998

	1996	1997	1998p
		(000 t)	
Australia	311	271	285
Belgium/Luxembourg	354	373	368
Brazil	172	177	167
Canada	559	560	563
Chile	1 748	2 117	2 335
China	1 119	1 179	1 211
Germany	671	674	695
Japan	1 251	1 279	1 278
Kazakstan	267	301	325
South Korea	245	263	369
Mexico	242	297	447
Peru	338	384	407
Philippines	156	147	152
Poland	425	441	447
Russia	570	580	550
Scandinavia	271	277	280
Spain	264	292	305
United States	2 341	2 450	2 458
Zambia	334	336	304
Other	1 036	1 082	1 016
Total	12 674	13 480	13 962

Source: International Copper Study Group.
p Preliminary.

TABLE 5. WORLD REFINED COPPER CONSUMPTION, 1996, 1997 AND 1998

	1996	1997	1998p
		(000 t)	
Australia	180	182	159
Belgium/Luxembourg	359	364	345
Brazil	235	255	302
Canada	218	225	246
China	1 293	1 285	1 397
France	518	558	580
Germany	960	1 039	1 138
India	202	186	253
Italy	504	521	590
Japan	1 481	1 441	1 254
South Korea	579	624	560
Poland	223	233	270
Russia	170	170	170
Scandinavia	251	265	277
Spain	191	203	230
Taipei, China	545	588	570
United Kingdom	397	384	374
United States	2 613	2 790	2 883
Other	1 701	1 779	1 783
Total	12 620	13 092	13 381

Source: International Copper Study Group.
p Preliminary.

TABLE 6. COPPER AND COPPER-NICKEL SMELTERS IN CANADA, 1998

Company and Location	Product	Rated Annual Capacity[1]	Feed Material	Remarks
		(000 tonnes)		
Falconbridge Limited Falconbridge, Ontario	Copper-nickel matte	23	Nickel-copper concentrates	Copper-nickel concentrate processed in fluid bed roasters and an electric furnace; 1800-t/d sulphuric acid plant treats roaster gases. Matte from the smelter is refined in Norway.
Inco Limited Sudbury, Ontario	Molten "blister" copper, nickel sulphide and nickel sinter for the company's refineries; nickel oxide sinter for market, soluble nickel oxide for market	135	Bulk nickel-copper concentrates, scrap	Oxygen flash-smelting of copper sulphide concentrate. Copper converters produce blister copper. Oxygen flash furnace for smelting of nickel-copper concentrate; converters for production of nickel-copper Bessemer matte. Production of matte followed by matte treatment, flotation, separation of copper and nickel sulphides, then by roasting to make nickel oxides for refining and marketing. Oxygen flash conversion of copper sulphide to semi-blister followed by pyrorefining to blister copper.
Falconbridge Limited Timmins, Ontario	Molten "blister" copper	125	Copper concentrates, scrap	Mitsubishi-type smelting, separation and converting furnaces. Hazelett continuous cast anodes. Incremental expansion will increase capacity to 140 000 t/y in 1999.
Noranda Inc. Horne smelter Rouyn-Noranda, Quebec	Copper anodes	200	Copper concentrates, scrap	New continuous converter commissioned in 1997.
Noranda Inc. Gaspé smelter Murdochville, Quebec	Copper anodes	110	Copper concentrates	Green charge reverberatory furnace, two converters, one rotary anode furnace and an acid plant. Additional converter will increase capacity to 135 000 t/y in 1999.
Hudson Bay Mining and Smelting Co., Limited (HBMS) Flin Flon, Manitoba	Copper anodes	90	Copper concentrates	Five roasting furnaces, one reverberatory furnace and two converters. Modernization planned but delayed indefinitely.

Source: Data were provided by the companies listed.
[1] Copper in matte, blister and anode.

TABLE 7. COPPER REFINERIES IN CANADA, 1998

Company and Location	Rated Annual Capacity	Remarks
	(tonnes)	
Noranda Inc. CCR Refinery Montréal-Est, Quebec	360 000	Refines anodes from Noranda's Horne and Gaspé smelters, and also from purchased scrap and anode scrap. Precious metals, selenium and tellurium are recovered from slimes. Modernization under way.
Inco Limited Copper Cliff, Ontario	175 000	Casts and refines anodes from molten converter copper from the Copper Cliff smelter, and also refines purchased scrap. Gold, silver, selenium and tellurium cake are recovered from anode slimes. Recovers and electrowins copper from Copper Cliff nickel refinery residue.
Inco Limited Copper Cliff, Ontario	15 000	Electrowinning plant processes copper-bearing fluids.
Falconbridge Limited Timmins, Ontario	120 000	Refines anodes from the Kidd Creek smelter. Incremental expansion will increase capacity to 140 000 t/y by year 2000.
Boliden Limited McLeese Lake, British Columbia	2 000	Dissolved copper-in-solution from heap leaching operations is treated in a solvent extraction plant and then electrowinned to produce copper cathode. Production suspended in December 1998. Operation sold to Taseko Mines Limited in April 1999.

Source: Data were provided by the companies listed.

TABLE 8. U.S. SUPPLY OF WIRE MILL, BRASS MILL, FOUNDRY AND POWDER PRODUCTS, AND THEIR CONSUMPTION IN END-USE MARKETS, 1997 AND 1998

United States	1997	1998p
	(000 t)	
SUPPLY		
Domestic mill products		
Building wire	630	643
Magnet wire	323	320
Telecommunications cable	268	272
Power cable	121	122
Automotive wire and cable	150	154
Electronic wire and cable	107	107
Other wire and cable	280	298
Strip, sheet, plate and foil	553	566
Rod and bar	541	540
Tube and pipe	537	564
Mechanical wire	44	44
Foundry products	180	183
Powder products	22	23
Total, domestic mill products	3 757	3 835
Imported mill products	82	81
Total supply	3 839	3 917
USES		
Building construction	1 577	1 620
Electrical/electronic products	980	1 019
Industrial machinery/equipment	446	439
Transportation equipment	476	484
Consumer and general products	360	354
Total	3 839	3 917

Source: Copper Development Association Inc.
p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 9. YEARLY AVERAGE COPPER PRICES,[1] 1980-98

Year	LME
	(current US¢/lb)
1980	99.0
1981	79.0
1982	67.1
1983	72.1
1984	62.5
1985	64.3
1986	62.3
1987	80.9
1988	117.9
1989	128.9
1990	121.0
1991	106.2
1992	103.7
1993	86.8
1994	104.7
1995	132.9
1996	104.1
1997	103.2
1998	75.1

Source: International Copper Study Group.
[1] Grade A, Cash.

TABLE 10. MONTHLY AVERAGE COPPER PRICES, 1997 AND 1998

	LME[1]		COMEX[2]	
	1997	1998	1997	1998
	(current US¢/lb)			
January	110.4	76.6	108.3	76.9
February	109.1	75.5	110.2	75.5
March	109.8	79.3	114.8	79.7
April	108.4	81.7	110.0	81.6
May	114.0	78.6	115.3	78.0
June	118.5	75.3	117.6	74.9
July	111.1	74.9	109.9	75.4
August	102.1	73.5	102.1	73.3
September	95.6	74.7	95.1	75.6
October	93.1	71.9	93.1	72.3
November	87.0	71.4	87.6	71.5
December	79.9	66.8	79.3	66.3

Source: International Copper Study Group.
[1] LME cash price for Grade A copper. [2] COMEX First Position High Grade price.

Diamonds

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SUMMARY

Major events in the Canadian diamond industry during 1998 included the following:

- On October 14, BHP Diamonds Inc. opened the Ekati mine in the Northwest Territories, the first major Canadian diamond mine.
- The Canadian government signed a three-year contract with Diamonds International Canada (DICAN) Ltd. to be the Canadian Government Diamond Valuator.
- Two companies and two schools began training diamond cutters in Canada.
- De Beers reduced its rough diamond sales by 28% to US$3.34 billion from US$4.64 billion in 1997.
- The continued downturn in the economies of Japan and other Asian countries, including Korea and Taiwan, resulted in reduced demand for finished goods throughout the year.
- De Beers extended its trade deal with Almazy Rossii-Sakha (Alrosa), the largest Russian diamond producer, through to the end of 2001. In the contract, De Beers (the Central Selling Organization (CSO)) will be guaranteed sales of at least US$550 million per year of rough stones from run-of-mine and the stockpile.
- In Angola, the country's first diamond mine at Catoca began production. The mine is a joint venture between Endiama of Angola and Alrosa of Russia as the major partners, with Odebrecht of Brazil and an Israeli diamond-trading company as minor partners.
- Israeli manufacturers who are not CSO sightholders now have access to a first-hand supply of rough stones. In June, a rough bourse in Tel Aviv was officially opened.

CANADIAN DEVELOPMENTS

Mine Developments

On October 14, 1998, BHP Diamonds Inc. (BHP), a wholly owned subsidiary of Broken Hill Pty Co. Ltd. of Australia, opened the first Canadian diamond mine. The Ekati diamond mine is located near Lac de Gras about 300 km northeast of Yellowknife in the Northwest Territories. The mine is owned 51% by BHP Diamonds, who is also the operator, 29% by Dia Met Minerals Ltd. of Kelowna, British Columbia, and 10% each by Charles Fipke and Stewart Blusson, both of Canada. Under the joint-venture agreement, BHP will market all diamond production for the first five years.

By the end of the year, the mine had produced nearly 200 000 carats (ct). Once full capacity is reached, annual production is expected to be about 3.5-4.5 Mct. At this level, the Ekati mine will account for about 4% of global diamond production by weight and 6% by value.

BHP spent nearly $200 million on the exploration and environmental assessment phase of the project. Following completion of the regulatory phase in January 1997, the company spent an additional $700 million on mining equipment, site development and construction of mine infrastructure, including a 9000-t/d processing plant.

Throughout the construction phase, BHP met commitments to maximize both northern purchases and northern hire. BHP employs about 550 people. Some 80% of the Ekati mine's staff are Northerners, of which over 50% are Aboriginals.

The mine's proven and probable kimberlite reserves total 78.0 Mt at an average grade of 1.09 ct/t (which is high by world standards). The current plan calls for the five pipes to be mined by open-pit and then

underground methods over a period of 17 years. The pipes are known as Panda, Koala, Fox, Misery and Sable. Their lifespan is widely expected to be extended to at least 25 years as additional pipes, such as Koala North and Beartooth, which have been identified for future bulk sampling, are exploited.

All of the pipes are within 35 km by air of each other. Panda is currently being mined and will be followed by Misery and Koala. The bulk sampling program results on the pipes are approximately as follows: Panda, 1.03 ct/t (diluted basis) evaluated at an average price of US$130/ct, for a value of US$134/t of ore; Misery, 4.26 ct/t at an average price of US$26/ct, for a value of US$111/t of ore; Koala, 0.95 ct/t at an average price of US$122/ct, for a value of US$116/t of ore; Fox, 0.40 ct/t at an average price of US$125/ct, for a value of US$50/t of ore; and Sable, 0.93 ct/t at US$64/ct, for a value of close to US$60/t of ore. As a whole, the diamonds average US$84/ct or US$91.50/t of ore. The operating costs will vary from about US$22 to $35/t of ore.

The Diavik diamonds project is a proposal to mine four kimberlite pipes located just offshore of a 20-km^2 island in Lac de Gras, approximately 300 km northeast of Yellowknife and 30 km southeast of BHP's Ekati diamond mine. The pipes are referred to as A-154 South, A-154 North, A-418 and A-21. Diamond grades and values are variable between the four pipes. An independent valuation conducted in 1998 of diamonds recovered from the bulk sampling of A-418 and A-154 South confirmed values of US$56/ct and US$63/ct, respectively. As of December 1998, reserves from the four pipes stood at 102 Mct contained in 26 Mt of kimberlite with a diluted grade of 3.9 ct/t. (This estimate, which was calculated to a depth of approximately 400 m, excludes inferred resources and takes into account underground mining plans.)

Diavik initiated a $30 million feasibility study in 1998 that it expects to complete in the second quarter of 1999. The study is examining the construction of three dykes to allow open-pit mining of the four pipes, with additional underground mining of the two higher-grade pipes (A-154 South and A-418). Mining and processing rates being examined range from 1.5 to 1.9 Mt of ore per year, yielding 6-8 Mct of diamonds annually at full production.

The project was submitted to the federal government for environmental assessment on March 8, 1998. The government established that the project would be assessed using the Comprehensive Study process as prescribed under the *Canadian Environmental Assessment Act*. Diavik filed its Environmental Assessment Report with the Canadian government on September 25 and, by the end of 1998, the project was about mid-way through the review process. Diavik expects to receive government approval by the second quarter of 1999 and the required licences and permits to allow construction and operations in the fourth quarter of 1999. Contingent on investor endorsement, construction of the $875 million project could begin in early 2000 with diamond production then beginning in mid-2002.

The Diavik diamonds project is a joint venture between Aber Resources Ltd. (40%) and Diavik Diamond Mines Inc. (60%). The latter company is a subsidiary of Rio Tinto plc and is the project manager. Each partner retains the right to market its own share of diamond production.

Canadian Government Diamond Valuator

In the Northwest Territories and Nunavut, the Canada Mining Regulations require that all diamonds produced in the territories be examined by a government valuator in order to establish a value for the diamonds for the purposes of calculating royalties owed to the Crown. The valuation must be done before the diamonds are sold or exported out of the territories.

In August 1998, the Canadian government signed a three-year contract with Diamonds International Canada (DICAN) Ltd. DICAN is a Canadian incorporated company with headquarters in Yellowknife, Northwest Territories. The company is a partnership between Aboriginal Diamonds Group Ltd. (51%) and WWW International Diamond Consultants Ltd. (49%).

DICAN has a team of nine individuals with expertise in the valuation of rough diamonds and statistical analysis of rough diamond production. As required by regulation, DICAN has provided the government with a value of diamond production from the Ekati mine for use in the calculation of royalties that BHP Diamonds Inc. will pay to the Crown.

Exploration Developments

In 1998, exploration for diamonds continued in several regions of Canada. Preliminary data indicate that diamond exploration expenditures declined from $92.2 million in 1997 to $73.9 million in 1998. Again, exploration was focussed principally in the Northwest Territories.

Monopros Ltd., the Canadian exploration arm of De Beers Consolidated Mines, announced late in 1998 that it would proceed with a $14 million bulk sampling program on the AK diamond property. The company plans to recover about 1000 ct from each of the Hearne, Tuzo and 5034 pipes, and an additional 200 ct from the Tesla pipe. The bulk sample will be processed at the Monopros dense media separation plant at Grande Prairie, Alberta, and the sample con-

centrates will be shipped to South Africa for final diamond recovery and evaluation. In addition to the bulk sample, Monopros has started delineation drilling to better define the resources in each of the four pipes. Based on earlier drilling, the company has estimated that the Hearne pipe contains about 8 Mt averaging 2.33 ct/t, the Tuzo pipe contains about 9 Mt averaging 2.20 ct/t, the 5034 pipe contains 15 Mt averaging 1.60 ct/t, and the Tesla pipe contains 4 Mt averaging 0.34 ct/t. Monopros, through a joint-venture agreement signed in 1997 with Mountain Province Mining Inc., which owns 90% of the AK property, and Camphor Ventures, which owns the other 10%, can earn up to a 60% interest in the property.

Lytton Minerals Limited and its joint-venture partners announced the discovery of a new pipe named Contwoyto-1 about 30 km east of the original Jericho pipes. The partners announced that analysis of a 90.2-kg core sample recovered 169 stones, of which 26 diamonds were greater than 0.5 mm in one direction and 12 of those were greater than 0.5 mm in two directions. Work is expected to continue during 1999.

Aber Resources Ltd. and Winspear Resources Ltd. continued the sampling program of the NW kimberlite dyke near Snap Lake on the Camsell lake property. During the summer, two 100-t samples about 250 m apart yielded a 226.72-ct parcel of diamonds. Included in the parcel were 25 diamonds weighing more than 1 ct each and the three largest stones weighed 10.82, 8.42 and 6.04 ct. In 1999, the partners are planning a $12 million program to collect a 6000-t bulk sample from the dyke in order to help verify its diamond potential.

Winspear Resources is continuing work on the Hilltop and Cache properties, which are immediately adjacent to the Camsell Lake property. The Cache property is a joint venture with SouthernEra Resources Ltd. (20%), while the Hilltop property is 100% owned by Winspear; Winspear is the operator at all three properties. Work on the Hilltop and Cache properties includes airborne magnetometer and electromagnetic surveys as well as till sampling. The company expects to continue its work during 1999 by spending $1.5 million on further delineation work.

Ashton Mining of Canada Inc. reported disappointing test results on its test of 479 t of mined soil and kimberlite. The company recovered only 56.45 ct larger than 1 ct in size. While the results are lower than expected, Ashton announced that it will continue exploring in Alberta and, at year-end, was awaiting the results of a 17-t sample taken from another pipe.

Structure of the Canadian Diamond Value-Added Industry

Diamond Cutting and Polishing

In comparison to other countries with cutting and polishing industries, the Canadian industry is quite small. However, the start of Canada's mine production of rough diamonds has created quite an interest in establishing new facilities in this country.

First, Canadian Diamond Cutting Works has set up a new operation in Montréal, Quebec. The company brought experienced cutters from Belgium to act as foremen and trainers to six local people interested in becoming diamond cutters and polishers. It expects to have a crew of about 20 employees processing 3000 ct per month within about two years.

Sirius Diamond Ltd., with a factory near Victoria, British Columbia, has begun polishing rough diamonds from the Ekati mine. The company has the first purchase agreement with BHP to produce cut and polished Canadian diamonds. As part of its sales promotion, Sirius laser engraves a polar bear on each Canadian diamond it polishes. Sirius has also provided training for Northerners in its factory so that, when its new facility now under construction in Yellowknife is completed, it will have trained local employees to start work. The facility is expected to employ 30 people within two years and, if its training program is a success, about 25 will be local hires. Initial production is expected to be at a rate of 2000 ct per month, rising to about 5000 ct per month as efficiencies and skills increase.

Other manufacturers include Cohenor and Hope Diamond with small factories in Montréal, Quebec, and Polar Star with a factory in Edmonton, Alberta.

New production facilities are expected to be built in Yellowknife to take advantage of being close to the source of the rough diamonds. At present, the Government of the Northwest Territories is reviewing about 10 proposals for building new operations in Yellowknife.

The General and Vocational College of Matane, Quebec (Collège d'enseignement général et professionnel (CÉGEP) de Matane), enrolled about 40 students in a course on diamond cutting and polishing for the 1998/99 winter term.

Aurora College in the Northwest Territories has also developed a diamond cutting and polishing course for northern students. In early October, Aurora College and Sirius Diamonds Inc. selected nine Northerners

(five men and four women) to begin a six-month training program to learn the skills of cutting and polishing diamonds. The program will be delivered at Sirius's facilities near Victoria, British Columbia, until its new operation opens in Yellowknife in May 1999. Following completion of the training program, the trainees will be employed by Sirius.

In addition, Aurora College has introduced a new course at its Yellowknife facilities entitled "Introduction to Diamonds." The 16-week course has space for 20 students who, upon completion of the course, will be qualified to apply for cutting and polishing jobs with Sirius.

Diamond Tools and Equipment Manufacturing

These products include drill bits, segments for circular blades, grinding wheels and specialty tools. The major manufacturing plants are: Fordia at Ville St-Laurent, Quebec; Diamond Production at Montréal, Quebec; North Star Abrasives at Montréal, Quebec; Diacan at Québec City, Quebec; Diamond Systems at Dorval, Quebec; Dimatec at Winnipeg, Manitoba; JKS Boyle, Longyear, JKS Lamage, and Pilot Diamond Tools, all in North Bay, Ontario; Diaset Products at Delta, British Columbia; and Hobic Bit Industry at Richmond, British Columbia.

Diamond Jewellery Manufacturing

There are approximately 20 major plants located mainly in the Toronto region with a few in Montréal. There are also several smaller plants in Montréal.

Synthetic Diamond Production

Crystalline Manufacturing Ltd. of Calgary, Alberta, produces synthetic diamond films using the Carbon Vapour Deposition (CVD) method.

WORLD PRODUCTION

Natural Rough Diamond Production

World production of natural rough diamonds in 1997 was estimated by Terraconsult bvba of Belgium at 119.7 Mct valued at US$6.9 billion, for an average price of US$58/ct. World production of natural rough diamonds grew from 43 Mct in 1980 to around 110 Mct/y in the mid-1990s, representing an increase of 4.5 Mct/y.

In 1997, the major producing countries included Botswana with 20 Mct valued at US$1.6 billion, Russia with 14.5 Mct valued at US$1.3 billion, South Africa with 10.3 Mct valued at US$983 million, Congo with 22.2 Mct valued at US$897 million, Angola with 5.3 Mct valued at US$806 million, Namibia with 1.1 Mct valued at US$410 million, and Australia with 40.2 Mct valued at US$322 million.

In Namibia, Namdeb (the Namibian government (50%) and De Beers (50%) joint venture) has installed a $40 million dredge that will allow the present production of 1.3 Mct/y to continue for the next 10 years.

In Angola, production at the Catoca kimberlite deposit began at the end of 1997. The joint-venture partners (Alrosa of Russia, Odebrecht of Brazil and the Angolan state-owned Endiama) have plans to gradually increase diamond production from 235 000 ct/y to 940 000 ct/y over the next nine years.

In Botswana there are plans to double the output of the Orapa mine from 6.7 Mct/y to 12.0 Mct/y by the year 2000.

In Australia, Ashton Mining Pty is continuing with the development of the Merlin mine project in the Northern Territory. The project, 77.4% owned by Ashton, is beginning phase one with the trial open-pit mining of four pipes. During this phase, ore grades are expected to be about 0.43 ct/t, which will generate revenues of about US$20 million per year.

Factors Affecting Diamond Mining

Grade

Grade is the weight of diamonds expressed as carats per tonne (ct/t) of ore. It varies widely from one mine to another, but generally falls somewhere between 0.3 and 1.3 ct/t. The value of the ore per tonne equals the grade times the average value per carat of all the individual diamonds in the deposit.

Size (Weight) of Rough Diamonds in the Deposit

Individually, rough diamonds can range in size from micro-sized to stones weighing in excess of 1000 ct. A much more telling measure of a mine's production is the average size of its rough diamonds. Depending on the mine, the average size of rough diamonds recovered can vary from 0.01 ct (about 1 mm in size) to more than 0.7 ct. Many mines in the world average about 0.4-0.5 ct per stone. It is interesting to note that the number of stones larger than 1 ct (0.2 g) produced at mines is very small (about 400 000 stones per year) and, in terms of total carats produced, this represents only about 0.5% of world production.

Mine Production Costs

According to different sources, production costs (excluding depreciation and interest) for kimberlites and lamproites are approximately US$5-$6/t for large and easy-to-access diamond mines operating in good climatic conditions, and are up to about US$35-$38/t

for small mines located in remote areas and operating under harsh climatic conditions. The total production costs for these mines are around US$15/t and US$40-$45/t, respectively.

Synthetic Diamond Production

Synthetic diamonds that are manufactured using the high-pressure and high-temperature method compete with natural industrial diamonds as an abrasive mineral, and with silicon carbide (SiC), alumina (Al_2O_3), tungsten carbide (WC) and cubic boron nitride (CBN) as a manufactured abrasive material. The value of world synthetic diamond production is estimated at US$650 million-$800 million. Most marketed synthetic diamonds are 0.6-0.8 mm and smaller. A very popular type of synthetic diamonds is called "Synthetic Diamond Abrasives" (SDA). It is used for sawing, drilling or milling hard stones, concrete aggregate, refractory materials, masonry and asphalt.

Industry sources indicate that a plant producing synthetic diamonds using the high-pressure and high-temperature method, with an annual capacity of 10 Mct, requires about 60-70 employees, while a plant with an annual capacity of some 50 Mct requires 160-170 employees. One large press of 10 000 t produces about 5-6 Mct of synthetic diamonds.

To produce diamond grit with grain sizes up to about 1 mm, the following method is used. High-purity graphite powder, either natural or synthetic, is mixed with a metal (nickel, cobalt or iron) powder alloy that serves as a solvent catalyst. The pressure is applied and then the temperature is raised with an electric current. Liquid metal alloy starts to dissolve the graphite. When the metal alloy becomes saturated, small crystals begin to crystallize out in the form of stable carbon, which is diamond. Synthetic diamonds are allowed to grow to a certain size. Then the temperature is decreased and when the crystals have somewhat cooled, the pressure is removed. The masses of hard material removed from the presses go to a chemical cleaning section where they are crushed and boiled in various acid baths that dissolve non-diamond materials. The diamonds are then cleaned, dried and sent to a sorting department.

In 1998, synthetic diamonds that are manufactured using the high-pressure and high-temperature method were produced in some 20 countries. The two leading producers are De Beers of South Africa and General Electric of the United States. Together these two companies control approximately 70% of world production, and both produce a full range of synthetic diamond products. The smaller producers specialize in certain sizes and types of products. De Beers has plants near Johannesburg in South Africa; at Robertsfors, Sweden; in Hamburg, Germany; on the Isle of Man, British Isles; and in Shannon, Ireland. General Electric has plants at Worthington, Ohio, and in Dublin, Ireland.

In many applications, synthetic diamonds are preferred to natural industrial diamonds because they can be tailored (size and shape) to the customer's needs.

In general, larger crystals are used for cutting softer materials and smaller crystals are used for the tougher materials.

Diamond Cutting and Polishing Industry

Natural diamonds are cut and polished in some 30-40 countries. The major diamond-cutting centres in the world are Kempen and Antwerp, Belgium; Ramat-Gan and Tel-Aviv, Israel; New York City; and Surat and Mumbai (formerly Bombay), India. With the exception of India, which is a very small producer of rough diamonds, none of these countries mine diamonds. Many other countries also cut diamonds, but their industries are small.

Canada's cutting industry is very small, but its potential is good as Canada will soon become an important producer of gem-quality diamonds, and Canadian labour costs are in line with those in New York, Antwerp, Australia and Israel. In 1997, De Beers reported that labour costs at manufacturing centres (based on the assumption that 1995 figures were used) were as follows (in U.S. dollars per hour): United States, $20; Belgium, $14; Israel, $12; South Africa, $4; and Moscow, $3.8. In Canada, average labour costs in U.S. dollars per hour were: Montréal, $7.5; Edmonton, $7.6; Vancouver, $8.5; and Toronto, $8.7. In rural regions such as the Gaspé, labour costs were $4.7 per hour.

De Beers' estimates of manufacturing costs at the major centres are as follows (in U.S. dollars): United States, $80/ct for +3-ct roughs; Belgium, $25-$40/ct for 0.5-1.0-ct roughs (although 1.0-2.5-ct roughs are more typical); Israel, $18-$30/ct for 0.2-1.0-ct roughs; and India, $10-$12/ct for 0.1-1.0-ct roughs. For the same size of roughs noted above, other sources indicate the manufacturing costs as: United States, $50-$100/ct; Belgium, $30-$60/ct; and Israel, $25-$50/ct.

Among the four major manufacturing centres, India, Israel and Belgium are net exporters of polished diamonds and the United States is a net importer of polished diamonds.

Belgium is the world's largest trading centre for rough and polished diamonds. Its total trade in 1996, the latest year for which statistics are available, was 260 Mct valued at close to US$23 billion. Trade in

rough stones was US$7.1 billion in imports and US$6.3 billion in exports, while trade in polished stones was US$4.4 billion in imports and $5.2 billion in exports.

India cuts more carats of rough diamonds than any other country. In fiscal year 1996/97, India imported 98 Mct of rough stones valued at US$3.26 billion (US$33/ct) and exported 18 Mct of polished stones worth US$4.2 billion (US$233/ct). About 90% of cuttable production from the Argyle mine in Australia is cut in India. Imports of rough stones in India have increased steadily from 38 Mct in 1990 to 98 Mct in 1997. During that period, import prices for rough stones have decreased steadily from a high of US$52/ct to US$33/ct. Exports of polished stones from India have increased steadily from 9 Mct in 1990 to 18 Mct in 1997; this growth rate is much higher than the growth rate for diamond jewellery sales. Therefore, as can be expected, export prices for polished stones decreased steadily from US$286/ct to US$233/ct during that same period.

Israel is the second largest exporting country of polished diamonds. In 1996, rough stones for local production of polished stones (net imports minus exports) amounted to 5.74 Mct valued at US$2.98 billion (US$520/ct), and net exports of polished stones were 3.8 Mct worth US$3.998 billion (US$1050/ct). Israel is also the leader in diamond cutting and polishing technology, including in the use of lasers and robots that cut, shape and polish diamonds. Israel cuts a very wide range of diamonds and is renowned for its fancy cuts.

New York cuts the largest and best-quality rough diamonds. In 1996, U.S. manufacturers, most of which are in New York City, imported rough stones worth US$730 million and exported rough stones (not suitable for local production of polished stones) worth US$170 million, for a net value of US$560 million. In 1996, U.S. trade in polished stones was US$2.2 billion in exports and US$5.8 billion in imports.

In Russia, most production of rough diamonds comes from Yakutia. As Russia wants to maximize employment, more diamonds mined in Russia are now cut in Russia. In 1997, preliminary figures indicate that the production of polished stones in Russia was valued at US$650 million-$700 million. Most production is exported as domestic sales of diamond jewellery only account for about US$30 million.

Diamond-cutting is relatively labour-intensive when compared to many other sectors. Automated cutting and polishing techniques are increasingly being used to compete with low-wage operations. The types of automated equipment being acquired include automatic girdling machines (sometimes connected with stroboscopes), automatic blocking and faceting machines, lasers to shape the roughs, and computers that suggest an optimal cut based on the shape and dimensions of, and inclusions in, a rough stone.

The major diamond-cutting centres have a very wide range of indirect jobs associated with them such as brokers, wholesalers, suppliers of machinery and equipment for cutters, bourses, insurance companies, travel agencies, jewellery manufacturing, etc.

Because of high labour costs, factories in New York cut bigger and better-quality diamonds. Belgium and Israel are in the middle of the labour-cost spectrum and, as a result, are generally involved in cutting stones of intermediate size and quality. India, with the lowest labour costs, cuts the smallest and least expensive diamonds. The literature also indicates that the average price per carat of polished diamonds produced in New York is about US$1400; in Antwerp, an estimated US$1000-$1100; in Tel Aviv, US$1000; and in India, US$250.

Employment related to diamond-cutting and polishing (manufacturing) changes from year to year and varies widely from factory to factory, running anywhere from 1 to 3000 workers. Total employment (full-time and part-time) in diamond manufacturing varies widely from country to country. For example, literature indicates that there are 500-600 cutters in the United States; around 3100 cutters in some 250 factories in Belgium; some 7000-8000 cutters in 35 factories in Thailand (there were no factories there in 1980); 7000 workers in some 450 factories in Israel; approximately 7000-8000 sawers, bruters and polishers in some 50 factories in Russia; 3000 workers in Sri Lanka; 1000 workers in 3 factories in Botswana; 1500 cutters in 120 factories in South Africa; 10 000 workers in 80 factories in China; and 600 000-700 000 workers in 30 000 factories in India.

Processing (Refining) Industrial Diamonds

Low-value natural and synthetic diamonds can be processed into higher-value products by simple methods. Processing methods for grit, powders and stones are as follows. Natural grit (about 40 microns to 1 mm in size) is crushed, washed, dried, screened into sizes, and separated into shapes (elongated vs. short) with the use of vibrating tables. The short are sold, while the elongated are ground again, and the cycle is repeated. Synthetic grit and powders are separated into sizes and shapes, cleaned of their surface impurities, and dried.

Stones (larger than 1 mm) are screened, separated into shapes and sold as such. These stones often find use as cutting tools in various manufacturing industries. Also, these stones can be lightly rounded mechanically and then laser drilled for use as

mechanical dies for wire production. There are no industrial diamond processing plants in Canada.

USES

Gem-Quality Diamonds

Gem-quality diamonds are used in jewellery. World retail sales of diamond jewellery have increased rapidly in the 1990s. In 1997, preliminary figures indicate that some 67 million pieces of diamond jewellery were sold worth US$52 billion, with a total diamond content value of some US$12 billion and a diamond content weight of 21 Mct. The major markets for diamond jewellery in 1996 in terms of diamond content value were approximately as follows: the United States, 34%; Japan, 28%; Europe, 14%; East Asia, 8%; and other countries, 16%.

Industrial Diamonds

Industrial diamonds are diamonds that do not meet the standards of gem-quality diamonds because of their colour, clarity, size or shape. Industrial diamonds include natural and synthetic diamonds.

Diamonds are the hardest substance known. For this reason, the major use for industrial diamonds is as an abrasive. Industrial diamonds are used in equipment that drill, cut, grind and polish rocks (such as granite and marble), nonferrous metals, carbon fibres, composites, glass, refractories, ceramics, concrete, plastics, masonry bricks, etc. Natural and synthetic diamonds are widely used in the automotive, advanced technology and aerospace industries.

PRICES

Natural Diamonds

Natural industrial diamonds: Crushing bort sells for about US30¢/ct; casting sells for US$1-$2/ct; industrial stones sell for US$7-$10/ct; flets (e.g., a high-quality thin macle) sell for US$50/ct; and dies (larger diamonds of high quality but with poor (often yellow) colour that makes them unsuitable as gems) sell for up to US$200/ct.

Gem-quality rough diamonds: The price of a rough stone depends on its carat weight, shape, clarity and colour. Prices vary widely, but the following is an indication of the prices paid at cutting and polishing factories for gem-quality rough stones: a 1-ct stone that sells for US$20 is very low quality, US$200 is medium quality, US$400 is good quality, and US$600 is top quality.

Synthetic Diamonds

Synthetic diamond prices depend on their particle strength, size and shape, and whether or not the diamonds are coated with a metal, etc. For this reason, there are several hundred prices for synthetic industrial diamonds. Generally speaking, synthetic diamonds used in grinding and polishing vary in price from US30¢/ct to US$1/ct. Strong and blocky material for use in sawing and drilling, and known in the trade as SDA and MBS (produced respectively by De Beers and General Electric), sells for up to US$3/ct. Large single crystals with excellent structure for use in specific applications sell for several hundred dollars per carat.

FORECAST AND OUTLOOK

Increases in the production of natural diamonds during the next few years will come mainly from an expansion at Orapa in Botswana, and from the Ekati mine once full production is met. Production at Jubilee in Russia is increasing and, if needed, De Beers could expand the Venetia, Finsch and Premier mines in South Africa. Finally, the Catoca mine in Angola will also add to world production levels. Production decreases will probably come from the Argyle mine in Australia and from the Udachny mine in Russia.

Worldwide, the demand for polished diamonds of a size between 0.75 ct and 2-3 ct with good colour and clarity is expected to continue to be strong. The surplus of small inexpensive polished diamonds should continue for a few years.

Prices for natural industrial diamonds should continue to decline if world production remains at its present level, or increases, due to strong competition from synthetic diamonds.

Synthetic diamonds will continue to replace natural industrial diamonds.

On the production side, the production of synthetic diamonds should continue to grow at a healthy rate.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of February 26, 1999.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
7102.10	Diamonds, unsorted, whether or not worked, but not mounted or set	Free	Free	Free	Free
7102.21	Diamonds, industrial, unworked or simply sawn, cleaved or bruted, but not mounted or set	Free	Free	Free	Free
7102.29	Diamonds, industrial, other	Free	Free	Free	Free
7102.31	Diamonds, non-industrial, unworked or simply sawn, cleaved or bruted	Free	Free	Free	Free
7102.39	Diamonds, non-industrial, other	Free	Free	Free	Free
7105.10	Natural or synthetic diamond dust or powder	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999.

TABLE 1. CANADA, PRODUCTION AND DIAMOND TRADE, 1996-98

Item No.		1996 (carats)	1996 ($000)	1997 (carats)	1997 ($000)	1998p (carats)	1998p ($000)
PRODUCTION							
	Northwest Territories	–	–	–	–	278 431	53 425
	Total	–	–	–	–	278 431	53 425
EXPORTS							
7102.10	Diamonds, unsorted, whether or not worked, but not mounted or set						
	United States	. .	341	. .	113	–	–
	India	. .	48	. .	47	–	–
	Guyana	–	–	. .	63	–	–
	Total	. .	389	. .	223	–	–
7102.21	Diamonds, industrial, unworked or simply sawn, cleaved or bruted						
	United States	1 091	46	5 978	59	2 946	74
	Romania	9 698	145	–	–	–	–
	Total	10 789	191	5 978	59	2 946	74
7102.29	Diamonds, industrial, other						
	United States	115	41	122	88	248	107
	Belgium	19 047	116	–	–	–	–
	Other countries	30 319	129	1 881	35	–	–
	Total	49 481	286	2 003	123	248	107
7102.31	Diamonds, non-industrial, unworked or simply sawn, cleaved or bruted						
	United States	712	110	3	16	10 354	329
	Belgium	2 272	34	–	–	–	–
	Australia	–	–	1 061	220	–	–
	Total	2 984	144	1 064	236	10 354	329
7102.39	Diamonds, non-industrial, other						
	United States	22 229	12 954	7 707	10 491	1 556	5 210
	Belgium	3 387	1 654	1 439	1 143	502	569
	Israel	808	783	533	844	339	337
	Other countries	811	311	358	496	102	182
	Total	27 235	15 702	10 037	12 974	2 499	6 298
7105.10	Natural or synthetic diamond dust and powder						
	United States	107 491	82	83 710	46	93 851	58
	Total	107 491	82	83 710	46	93 851	58

TABLE 1 (cont'd)

Item No.		1996		1997		1998p	
		(carats)	($000)	(carats)	($000)	(carats)	($000)
IMPORTS							
7102.10	Diamonds, unsorted, whether or not worked, but not mounted or set						
	India	. .	6 245	. .	6 453	. .	13 322
	United States	. .	9 489	. .	9 869	. .	9 129
	Belgium	. .	9 824	. .	6 706	. .	8 931
	Israel	. .	6 999	. .	6 901	. .	8 169
	United Kingdom	. .	789	. .	1 132	. .	790
	Other countries	. .	2 833	. .	2 025	. .	1 460
	Total	. .	36 179	. .	33 086	. .	41 801
7102.21.00.10	Diamonds, industrial, bort and black, diamonds for borers, unworked or simply sawn, cleaved or bruted, but not mounted or set						
	United States	–	–	–	–	. .	524
	Ghana	–	–	–	–	. .	336
	Other countries	–	–	–	–	. .	752
	Total	–	–	–	–	. .	1 612
7102.21.00.90	Diamonds, industrial, other, unworked or simply sawn, cleaved or bruted, but not mounted or set						
	Belgium	–	–	–	–	52 678	374
	United States	–	–	–	–	30 852	227
	Israel	–	–	–	–	14 922	138
	Other countries	–	–	–	–	30 954	221
	Total	–	–	–	–	129 406	960
7102.21.10	Diamonds, industrial, bort and black, for borers, unworked or simply sawn, cleaved or bruted, but not mounted or set						
	United States	176 522	641	226 395	845	–	–
	United Kingdom	19 857	143	28 261	195	–	–
	Ireland	94 081	281	53 867	180	–	–
	Belgium	53 471	535	93 223	662	–	–
	Ghana	58 958	393	127 420	458	–	–
	Congo, Democratic Republic of the	31 697	197	35 612	161	–	–
	Other countries	133 057	386	49 754	226	–	–
	Total	567 643	2 576	614 532	2 727	–	–
7102.21.90	Diamonds, industrial, other than bort and black, for borers, unworked or simply sawn, cleaved or bruted, but not mounted or set						
	Belgium	–	–	172 501	1 933	–	–
	Ireland	24 212	99	98 442	415	–	–
	United States	35 457	140	19 842	99	–	–
	Other countries	13 997	142	10 031	69	–	–
	Total	73 666	381	300 816	2 516	–	–
7102.29.00.10	Diamonds, industrial, other, bort and black diamonds, for borers, but not mounted or set						
	United States	–	–	–	–	1 086	181
	India	–	–	–	–	559	175
	Other countries	–	–	–	–	8 648	148
	Total	–	–	–	–	10 293	504
7102.29.00.90	Diamonds, industrial, other than bort and black, for borers, worked but not mounted or set						
	Ireland	–	–	–	–	299 376	1 888
	Belgium	–	–	–	–	817	215
	United States	–	–	–	–	4 340	176
	Other countries	–	–	–	–	6 137	182
	Total	–	–	–	–	310 670	2 461
7102.29.10	Diamonds, industrial, bort and black, for borers, worked, but not mounted or set						
	United States	43 379	161	1 973	70	–	–
	Australia	–	–	796	23	–	–
	Other countries	39 278	446	6 125	24	–	–
	Total	82 657	607	8 894	117	–	–

TABLE 1 (cont'd)

Item No.		1996		1997		1998p	
		(carats)	($000)	(carats)	($000)	(carats)	($000)
IMPORTS (cont'd)							
7102.29.90	Diamonds, industrial, other than bort and black, for borers, worked, but not mounted or set						
	Ireland	1 155 991	4 359	704 328	3 241	–	–
	Belgium	3 498	56	11 964	981	–	–
	United States	345 842	2 228	111 025	777	–	–
	Other countries	38 789	493	11 035	512	–	–
	Total	1 544 120	7 136	838 352	5 511	–	–
7102.31	Diamonds, non-industrial, unworked or simply sawn, cleaved or bruted, not mounted or set						
	Belgium	738	803	2 016	1 571	2 568	1 923
	Israel	–	–	142	116	1 454	950
	Brazil	–	–	1 023	760	11 539	794
	Other countries	480	160	152	51	1 462	605
	Total	1 218	963	3 333	2 498	17 023	4 272
7102.39.00.10	Diamonds, non-industrial, other, of a weight not exceeding 0.5 carats each						
	Israel	37 241	28 832	29 339	22 999	31 026	21 859
	Belgium	20 584	13 732	12 094	10 274	16 371	14 459
	United States	7 686	6 477	9 327	8 203	8 020	7 029
	India	7 524	2 781	7 631	2 703	9 347	3 172
	Other countries	504	399	609	1 156	1 737	1 015
	Total	73 539	52 221	59 000	45 335	66 501	47 534
7102.39.00.20	Diamonds, non-industrial, other, of a weight exceeding 0.5 carats each						
	Israel	25 345	23 392	36 673	34 063	44 161	55 344
	Belgium	41 379	30 962	45 072	37 574	53 346	45 104
	India	34 679	8 497	60 178	20 132	66 205	23 686
	United States	14 725	14 317	17 989	22 108	16 655	20 825
	Other countries	2 946	2 556	3 888	5 039	3 102	2 266
	Total	119 074	79 724	163 800	118 916	183 469	147 225
7105.10.00.10	Diamond dust for borers; dust mixed with a carrier in cartridges or in tubes						
	United States	–	–	–	–	551 697	1 610
	Other countries	–	–	–	–	59 504	189
	Total	–	–	–	–	611 201	1 799
7105.10.00.91	Natural diamond dust and powder						
	United States	–	–	–	–	113 444	331
	Other countries	–	–	–	–	38 033	81
	Total	–	–	–	–	151 477	412
7105.10.00.92	Synthetic diamond dust or powder						
	Ireland	–	–	–	–	387 965	1 172
	United States	–	–	–	–	1 058 437	1 034
	Other countries	–	–	–	–	134 790	329
	Total	–	–	–	–	1 581 192	2 535
7105.10.10	Diamond dust for borers; dust mixed with a carrier in cartridges or in tubes						
	United States	914 754	2 325	2 309 406	6 333	–	–
	Ireland	72 767	244	402 040	1 139	–	–
	Other countries	28 358	109	62 488	171	–	–
	Total	1 015 879	2 678	2 773 934	7 643	–	–
7105.10.91	Natural diamond dust and powder						
	United States	39 369	125	125 343	389	–	–
	Other countries	17 495	28	12 177	49	–	–
	Total	56 864	153	137 520	438	–	–
7105.10.92	Synthetic diamond dust and powder						
	Ireland	954 114	2 975	1 029 604	2 785	–	–
	United States	1 796 748	4 860	1 006 125	1 932	–	–
	Italy	112 887	377	45 399	139	–	–
	Other countries	127 595	297	104 458	300	–	–
	Total	2 991 344	8 509	2 185 586	5 156	–	–

Source: Statistics Canada.
– Nil; . . Not available; p Preliminary.
Note: Numbers may not add to totals due to rounding.

Gold

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Canada's gold output decreased by 3.1% to 166.1 t in 1998. Canada is the world's fourth largest gold producer behind South Africa, the United States and Australia. The value of Canadian gold shipments decreased by 8.1% to $2.3 billion in 1998.

The average price of gold decreased to US$294.11/troy oz in 1998, its lowest annual price since 1978, from $331.03/oz (London a.m. fix) in 1997. The price volatility was moderate with gold trading in a range of US$314.60-$273.40/oz. In addition to the threat of widespread central bank gold sales, the gold price was depressed because of the strengthening of the U.S. dollar and the sharp drop in gold consumption.

Unless gold prices recover to above $320/oz before the end of 1999, Canada's gold production will likely decline to around 155 t/y in 2000. It is expected that potential future sales by the Swiss National Bank by the year 2000 could further erode market confidence. Because of this low gold price environment, it is expected that several companies will merge to improve their financial performance.

Canadian Developments

There were about 40 primary gold mines operating in Canada at the end of 1998 accounting for 92.2% of the gold produced. The rest of the gold production came from base-metal mines (6%) and placer operations (1.8%). During 1998, three mines opened and two closed, while others resorted to layoffs to deal with low prices. In addition, several mine openings and expansions have been postponed until market conditions improve. Employment in primary gold mines in 1997 totalled 9656, compared to 10 099 in 1996. Employment figures in the gold industry have been generally declining from their 1989 peak of 12 631.

British Columbia

British Columbia's gold production increased by 24.1% to 21.7 t in 1998 from 17.5 t in 1997.

Royal Oak Mines Inc. started commercial production at the Kemess gold project in October 1998 at a rate of 6.5 t/y. Kemess has reserves of 200 Mt grading 0.63 g/t gold and 0.22% copper.

The Eskay Creek project of Homestake Mining Company is British Columbia's largest gold producer with an output of approximately 8 t in 1998. The ore at the Eskay Creek mine, which began production in 1995, is shipped to smelters in Japan and North America. Homestake completed the construction of a $17 million, 150-t/d milling facility at the Eskay Creek mine. The mill treats material from ore zones that is amenable to gravity and flotation concentration. Eskay Creek is one of the highest-grade deposits in the world with reserves of 1.3 Mt grading 63 g/t gold.

Homestake Mining's Snip mine is expected to close by the middle of 1999 due to exhaustion of ore reserves. The Snip mine has a production capacity of 4 t/y.

Northwest Territories and the Yukon

Gold production in the Northwest Territories (N.W.T.) and the Yukon decreased by 54.3% from 20.8 t in 1997 to 9.6 t in 1998. This major decline in production is the result of the closure of Royal Oak Mines Inc.'s Colomac mine (4 t/y) in early 1997 and Echo Bay Mines Ltd.'s Lupin mine (5 t/y) in early 1998. High operating costs and the low price of gold caused these mines to close. In addition, Miramar Mining Corporation's Con mine was closed from May until December 1998 because of a labour conflict.

A total of 900 jobs were lost in the N.W.T. as a result of the closure of these two mines and as a result of layoffs at Royal Oak's Giant mine (25) and Miramar's Con mine (130). Operating costs in N.W.T. gold mines are particularly high due to high wages and high transportation and energy costs.

Figure 1
Primary Canadian Gold Mines and Principal Gold Refineries, 1998

PRIMARY GOLD MINES

Yukon
1. Viceroy Resources Corporation – Brewery Creek mine
2. B.Y.G. Natural Resources Inc. – Mt. Nansen mine

Northwest Territories
1. Royal Oak Mines Inc. – Giant mine
   Miramar Mining Corporation – Con mine

British Columbia
1. Homestake Mining Company – Eskay Creek mine
2. Imperial Metals Corporation/Sumitomo Corp. – Mount Polley mine
3. Homestake Mining Company – Snip mine
   North American Metals Corp. – Golden Bear mine

Saskatchewan
1. La Ronge Area
   Claude Resources – Seabee mine

Manitoba
1. Black Hawk Mining Inc. – Keystone mine
2. TVX Gold Inc./High River Gold Mines Ltd. – New Britannia mine
3. Harmony Gold Mining Company – Bissett mine

Ontario
1. Red Lake Area
   Placer Dome Inc. – Campbell mine
   Goldcorp Inc. – Red Lake mine
2. Pickle Lake Area
   Placer Dome Inc./TVX Gold Inc. – Musselwhite mine
3. Hemlo Area
   Homestake Mining Company/Teck Corporation – Williams mine
   Battle Mountain Gold Company – Golden Giant mine
   Homestake Mining Company/Teck Corporation – David Bell mine
4. Timmins – Kirkland Lake Area
   Placer Dome Inc. – Dome mine
   Royal Oak Mines Inc. – Pamour, Hoyle and Nighthawk Lake mines
   Kinross Gold Corporation – Hoyle Pond mine

Ontario (cont'd)
4. Timmins – Kirkland Lake Area (cont'd)
   Kinross Gold Corporation – Macassa mine
   Barrick Gold Corporation – Holt-McDermott mine
   Battle Mountain Gold Company/Teddy Bear Valley Mines, Limited – Holloway mine
   Exall Resources Limited/Glimmer Resources Inc. – Glimmer mine
5. Placer Dome Inc. – Detour Lake mine
6. River Gold Mines Ltd. – Eagle River and Edwards mines

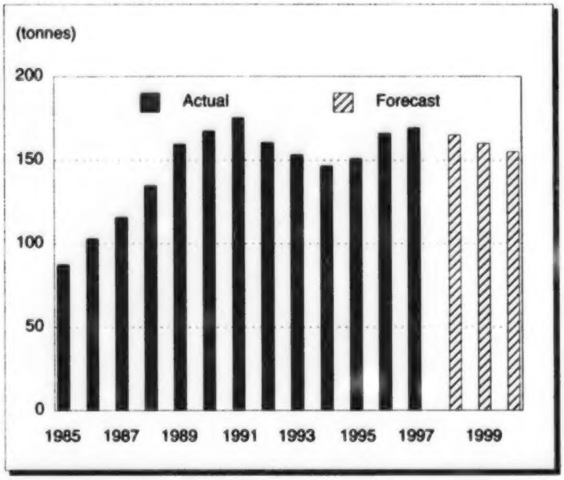
Quebec
1. Desmaraisville – Chibougamau Area
   Campbell Resources Inc. – Joe Mann mine
2. Rouyn-Noranda – Val-d'Or Area
   Barrick Gold Corporation – Bousquet mine
   Agnico-Eagle Mines Limited – LaRonde mine
   McWatters Mining Inc. – Sigma and Kiena mines
   Cambior inc./Aurizon Mines Ltd. – Sleeping Giant mine
   Cambior inc. – Doyon and Mouska mines
   Richmont Mines Inc. – Francœur mine
   Western Quebec Mines Inc. – Joubi mine
   Aurizon Mines Ltd./Louvem Mines Inc. – Beaufor mine

Newfoundland
1. Richmont Mines Inc. – Nugget Pond mine

PRINCIPAL GOLD REFINERIES

1. Noranda Inc., CCR Division
2. Royal Canadian Mint
3. Johnson Matthey Limited

Figure 2
Canadian Gold Production, 1985-2000



Source: Natural Resources Canada.

Saskatchewan

Following the closure of Cameco Corporation's Contact Lake mine in the middle of 1998, Claude Resources Inc.'s Seabee mine became the only operating gold mine in Saskatchewan.

Manitoba

Manitoba's gold production increased by 3.3% in 1998 to 8.4 t. Most of its gold production is derived from Black Hawk Mining Inc.'s Keystone mine and TVX Gold Inc.'s New Britannia mine. Both mines are located in the Lynn Lake region.

The Bissett gold mine, located near Bissett, was re-opened in the summer of 1998 by Harmony Gold. It had been closed since November 1977 due to low gold prices and financial problems by the previous owner, Rea Gold Corporation. Bissett's target production was initially planned to be nearly 3 t/y of gold.

Ontario

Ontario's gold production increased by 4.2% to 84 t in 1998, compared to its 1997 level of 80.6 t. The increase in Ontario's production was mainly due to a full year of production at the Musselwhite mine owned by Placer Dome Inc. (68%) and TVX Gold Inc. (32%). The Musselwhite mine, which is located in northwestern Ontario, has a production capacity of 6 t/y.

The three mines in the Hemlo area accounted for 35.3% of Ontario's total gold production in 1998. Claude Resources re-opened the old Madsen mine in the Red Lake region. Annual production at the Madsen mine is expected to be around 1.5 t. As a result of the low gold price and reserve depletion, Placer Dome Inc. announced that the Detour Lake mine will close in the middle of 1999. Its current production rate is approximately 3.8 t/y.

Goldcorp Inc. plans to re-open the Red Lake mine by the year 2000. Estimated production at the Red Lake mine is expected to be 8 t/y.

Ontario's output of gold is expected to remain relatively stable at around 85 t/y until the end of the decade.

Quebec

Quebec's gold production increased by 2.1% from 37.2 t in 1997 to 38 t in 1998.

The Casa Berardi mine was purchased by Aurizon Mines from TVX Gold Inc. Once an exploration program is completed, Aurizon will conduct a feasibility study to determine if the Casa Berardi mine should be re-opened.

McWatters Mining plans to bring the East Amphi mine on stream in 1999. The gold production level at East Amphi is expected to reach 0.5 t/y.

Future gold production increases in Quebec include Cambior inc.'s Doyon and Mouska mines, which will likely increase their combined production level from 6 t/y to 10 t/y by the year 2000.

Newfoundland

The Nugget Pond mine of Richmont Mines Inc. is the only operating gold mine in Newfoundland.

WORLD DEVELOPMENTS

South Africa

Despite a 3% decline in production, South Africa remained the world's largest gold producer in 1998 with an estimated output of 478 t. South Africa's share of world production was estimated at 19% in 1998, compared to approximately 66% in 1970.

South Africa has moved from being the lowest-cost gold producer in 1985 to being one of the highest-cost producers. Cash costs in South Africa in 1985 were approximately US$147/oz, while cash costs at other major Western World producers averaged about $200/oz. However, by 1998, South Africa had a cash cost of $252/oz, compared to the average Western World cost of $209/oz. In South Africa, wages represent approximately 50% of total production costs.

Anglogold Ltd., which was formed in June 1998 through a merger of the gold interests of Anglo American Corporation of South Africa Limited and its associated companies, is the world's largest gold producer with an estimated annual production of 200 t in 1998.

In December 1998, Anglogold and Minorco reached an agreement in principle under which Anglogold will purchase Minorco's gold interest for US$550 million. This acquisition would boost Anglogold's production to around 235 t/y.

The world's second largest gold producer, Gold Fields Ltd., was created as a result of the merger of Gold Fields of South Africa Ltd. and Gencor Ltd. in 1997. Gold Fields has an estimated annual production of 130 t.

Placer Dome Inc. announced in November 1998 that it had reached an agreement in principle with Western Areas Limited of Johannesburg to form a 50-50 joint venture that will develop and operate the South Deep mine and Western Areas' adjacent mining operations. Under current plans, South Deep, which has total reserves of around 1800 t, is expected to produce 11 t/y by the year 2002.

Despite the fact that South Africa accounts for 40% of the world's identified gold reserves, its gold industry faces major difficulties due to declining ore grades (which declined from 13 g/t gold in 1973 to around 5 g/t in 1997), the extreme depth of gold reserves (an average depth of 2500 m), and intensifying competition from low-cost producing countries.

It is expected that in order to remain competitive, some South African companies will have to close their operations. These closures will reduce the employment in gold mines, which is currently about 300 000 employees.

Because some major projects are scheduled to come on stream before the year 2000, South Africa's gold production level is expected to remain above 450 t/y until the end of the decade.

United States

Gold production in the United States in 1998 is expected to remain stable at around 360 t. U.S. gold production has experienced a decade of rapid growth from its 1985 level of 80 t. The United States is the world's second largest gold producer behind South Africa and is the world's lowest cash cost producer at US$178/oz.

According to the U.S. Geological Survey, 25 mines yielded about 75% of the gold produced in the country. The state of Nevada, with an estimated production of 245 t, was the lead producing state. Several heap leaching operations in Nevada accounted for about two thirds of U.S. production. The other major producing states were California and Montana.

Newmont Gold Corporation became North America's largest gold producer following its recent acquisition of Santa Fe Pacific Gold Corp. As a result of this acquisition, Newmont's 1998 gold production increased from 53 t to 90 t.

Barrick Gold Corporation operates the Goldstrike and Meikle mines in Nevada. The combined output of these two operations was around 70 t in 1998.

Placer Dome Inc. (60%) and Kennecott Minerals Company (40%) own the Cortez mine, which produced approximately 30 t at a cash operating cost of around US$55/oz in 1998. Total reserves at Cortez are 55 Mt grading 2.5 g/t gold.

After a period of substantial growth, gold production in the United States is expected to decline slightly to around 350 t/y by the end of the decade.

Australia

Australia's gold production decreased by 1% to an estimated 308 t in 1998. Its gold production has shown a spectacular increase over the past 11 years from its 1985 level of 59 t. The growth in Australia's gold industry was made possible by the success of its mining companies continuing their underground operations once their open-pit reserves were exhausted. Australia's gold production is derived mainly from Western Australia (75%), Queensland (12%), the Northern Territory (7%) and New South Wales (3%).

Australian gold mines, which had an estimated average cash cost of around US$205/oz in 1998, were the world's second highest-cost producers behind South Africa ($252/oz). However, the use of forward sales has shielded the industry from declines in the price of gold and has enabled higher-cost producers to maintain and, in some cases, expand output.

In New South Wales, Newcrest Mining Limited brought the Cadia Hill mine on stream in September 1998 at a cost of A$400 million. Cadia Hill, which is scheduled to produce 9 t/y, has reserves of 200 Mt grading 0.74 g/t gold and 0.17% copper.

Because of the current low gold price, Australia's gold production is expected to decrease to around 280 t/y by the year 2000.

Asia and Pacific Rim Countries

In addition to being prolific regions for gold production, Asia and Pacific Rim countries are very significant gold consumers.

China

China's gold production increased by about 5% to 164 t in 1998. According to the Gold Administration Bureau of the Ministry of Metallurgical Industries (MMI), the four provinces that account for 55% of Chinese gold production are Shandong, Henan, Hebei and Shanxi.

It is reported that the majority of China's 600 mines produce less than 0.3 t/y of gold each, with only 40 operations producing more than 0.3 t/y each. The majority of China's production is derived from lode deposits (75%); the balance of output is 15% from placer deposits (mainly from the Heilongjiang Province) and 10% as a by-product of base-metal deposits (primarily copper mines from the Jiangxi and Anhui provinces).

The main government organization producing gold is the China National Gold Corporation (CNGC), which accounts for 10% of China's gold production. The CNGC reports to the MMI's Gold Administration Bureau, which has responsibility for overall policy formulation, management, monitoring and coordination.

By law, gold producers have to sell their entire production to the People's Bank of China (PBOC).

According to the World Gold Council, current gold consumption in China is around 0.2 g/y per person, compared to 8 g/y in Taiwan. The average annual salary for citizens living in the largest 100 cities in China is US$500. As this figure increases, so should gold demand.

China mints 99.9%-pure gold and silver Panda coins. According to the China Gold Coin Corporation, gold coin sales are estimated at 3 t/y. The gold coins are available in five sizes ranging from one ounce to one twentieth of an ounce.

Should gold prices remain weak, it is expected that China, which currently faces increased production costs, may experience some difficulties in maintaining its production level above 160 t/y in 2000.

Indonesia

Indonesia's gold output increased by 20% to 121 t in 1998. Its gold production is likely to continue to grow at a rapid pace.

The bulk of Indonesia's production is from Freeport McMoRan Copper & Gold Inc.'s Ertsberg/Grasberg copper-gold mine. The company recently completed a fourth expansion of the concentrator that boosted capacity to around 210 000 t/d. Gold production by Freeport McMoRan was around 60 t in 1998. Proven and probable reserves stand at 2 billion t grading 1.18 g/t gold, 3.8 g/t silver and 1.19% copper. The precious metals content of the ore represents 1720 t of gold and 3691 t of silver.

In addition, Newmont Gold Corporation announced that the Batu Hiau copper-gold project will start production at the end of 1999. The Batu Hiau mine, which is expected to cost US$1.9 billion to develop, will produce in excess of 15 t/y of gold as well as significant copper values. Batu Hiau is owned by Newmont Gold (45%), Sumitomo Metal Mining Co., Ltd. (35%) and an Indonesian partner (20%).

Other major producing mines in Indonesia include Rio Tinto Limited's Kelian mine and Newmont Gold's Minhassa mine.

Papua New Guinea

Papua New Guinea's (PNG) gold production in 1998 increased by 27% to 63 t. This sharp increase in production is the result of a full year of production at the Lihir mine.

Gold production at the new Lihir mine was expected to reach 16 t in 1998 and to reach 21 t in 1999. Lihir has mineable reserves of approximately 100 Mt grading an average of 3.25 g/t gold. Its cash operating cost is expected to be around US$200/oz for the first five years of the project.

Production from the Porgera gold mine remained stable at around 22 t in 1998. Porgera's proven and probable reserves are 40 Mt grading 4.3 g/t gold. The mine is owned by Placer Dome Inc. (50%) (the operator), Renison Goldfields Consolidated Ltd. (25%) and the Government of PNG (25%).

The OK Tedi gold-copper mine is owned by The Broken Hill Proprietary Company Limited (52%), Inmet Mining Corporation (18%) and the PNG government (30%). The mine has reserves of 300 Mt grading 0.8 g/t gold and 0.8% copper, and a production capacity of 15 t/y of gold.

Placer Dome Inc. announced that mining of its 80%-owned Misima mine will cease during 1999 due to high operating costs. However, milling of ore stockpiles is expected to continue until the year 2000. Misima's 1998 gold production was 6 t.

Commonwealth of Independent States

Gold production in the C.I.S. was estimated to be 250 t in 1998. The general decline in production from a peak of over 285 t in 1989 is largely attributed to the exhaustion of some placer deposits (particularly in Russia) and a shortage of hard currency to develop new mines. About 20% of the C.I.S.'s annual gold production is believed to originate as a by-product of base-metal operations, particularly copper.

As a result of foreign investment, gold production in the C.I.S. is expected to remain stable over the next few years even though there will be a further decline in placer gold production in Russia.

Russia

Within the Russian government, policy functions pertaining to production and refining processes are handled by the Ministry of the Economy. Other responsibilities such as assaying and the sale and use of precious metals and stones are functions of the Ministry of Finance. Organizations that report to the Ministry of Finance include the Central Bank of Russia and Gokhran. The Ministry of Finance has the right of first refusal to purchase precious metals from mining companies.

Russia's gold production in 1998 was reported to have remained stable at around 120 t. Currently, Russia's production originates mostly from the Far East (62%), East Siberia (24%) and the Ural mountains (12%). The decreased Russian production can be attributed principally to declining reserves at several alluvial operations, high taxes, and late payments by central authorities. Other problems include high import taxes for machinery and a shortage of funds for geological surveys.

About 80% of Russia's gold production comes from placer deposits, but these deposits account for only 20% of the total proven reserve base. As gold reserves are generally concentrated in large low-grade deposits, Russia's gold production will likely continue to decline in the medium term.

Russia's gold output is produced by state-owned enterprises as well as by private enterprises and cooperatives known as Artels. There are about 350 producers with various forms of ownership, including 200 Artels that generally operate small placer deposits. Artels account for approximately 60% of Russia's total gold production originating mostly from Magadan, Yakutia and Chita.

Kinross Gold Corporation operates the Kubaka gold project in the Magadan region. Kubaka, which was built at a cost of US$228 million, is owned by the Omolon Mining Company in which Kinross has a 50% interest. The Kubaka mine is expected to produce 10 t/y for a period of five years.

Sukhoi Log, with estimated reserves of 400 Mt grading 2.6 g/t gold and potential production of 50 t/y, is reported to be one of the largest undeveloped gold deposits in the world. In 1998, the Russian government initiated an international tendering process to develop the deposit.

Natural Resources Canada conducted a survey in 1998 of 17 Canadian mining and exploration companies that are involved in the gold (15), silver (1) and diamond (1) sectors of Russia. A total of around $225 million (excluding the Kubaka project, which was initially developed by U.S.-based Amax Gold Inc.) was spent from 1995 to 1997 by Canadian companies on Russian projects. The major areas of expenses incurred by Canadian companies were in exploration, feasibility studies, development, and the acquisition of a minority ownership in a Russian joint-venture partner.

Uncertainty about Russia's legal framework and the jurisdictional conflicts between local and central authorities make the investment climate there unattractive. However, the enormous undeveloped potential of Russia, coupled with its high need for foreign investment, is expected to encourage authorities to make Russia's legal framework more attractive for foreign investment in mining. According to Russian government sources, Russia's gold mining industry would require more than US$5 billion to build or upgrade approximately 30 mining and milling complexes over the next four years.

Uzbekistan

Uzbekistan's gold production in 1998 decreased by 4% to 78 t. The largest producer is the Muruntau low-grade open-pit mine. It was commissioned in 1969 and is reported to have an annual production rate of 55 t. The mine treats about 20 Mt/y of ore grading 3 g/t gold.

Production at the Zarafshan tailings retreatment joint venture at Muruntau, which began operating in 1996, achieved an output of 14 t in 1998. The Zarafshan joint venture is owned by Newmont Gold (50%), and by the Uzbek State Committee of Geology and Mineral Resources and Navoi Mining and Metallurgical Combinat each with a 25% share. The joint venture calls for the reprocessing of the Muruntau gold tailings with reserves of 150 t of gold over a 16-year period.

Kazakstan

Kazakstan's 15-t/y gold production is derived mostly from the Ust-Kamenogorsk base-metal operation and from the Tselinny mining and chemical plant slag heaps.

No final decision has yet been reached regarding the privatization of the Vasilkovskoye gold deposit. Vasilkovskoye has a geological resource of 138 Mt grading 3 g/t gold.

Kyrgyzstan

Kyrgyzstan's 1998 gold production increased by 3 t to 20 t as the result of a production increase at the Kumtor mine.

The Kumtor mine is owned by Cameco Corporation (33%) and the Kyrgyzstan government (67%). Production at the US$450 million open-pit gold project started in January 1997. Gold production at Kumtor

reached 18.7 t in 1998. Kumtor has total estimated reserves of 500 t of gold, of which 200 t are amenable to open-pit mining. Grades at Kumtor are 3.9 g/t gold and its cash operating cost is approximately US$160/oz.

Following a truck accident that resulted in a spill of sodium cyanide on May 20, 1998, a scientific commission of international experts was assembled at the request of Kyrgyzstan to assess the impact. The findings of the Commission revealed that because of cyanide's rapid degradation, the spill had no serious effects on the environment.

Africa

Following important investments by international development agencies and local governments in geoscience activities, as well as the revision of mining codes and investment laws, increased attention is being devoted to gold exploration in African countries. Ghana and Mali are two good examples.

Ghana

Ghana's gold production has more than quadrupled in the past eight years from 17 t in 1990 to 69 t in 1998.

Gold production in 1998 at Ashanti Goldfields Company Ltd.'s Oabusi mine was expected to total 25 t. Production at the Oabusi gold mine is derived from underground operations, an open pit, and tailings retreatment. Total reserves at the mine are 90 Mt grading 7.1 g/t gold. Ashanti Goldfields is owned by Lonrho Plc (41.3%) and the Government of Ghana (31.3%), with institutional and private investors owning the remainder. Ashanti Goldfields also operates the Iduapriem (6 t/y), Ayanfuri (1 t/y) and Bibiani deposits in Ghana.

Gold Fields of South Africa Ltd. announced a production increase at the Tarkwa mine complex. In addition to the current underground operation that produced 1.4 t of gold in 1998, Gold Fields will commission an open-pit mine that will increase production from its current level to 8 t/y by the year 2000. The total resource at Tarkwa is 286.6 Mt grading 1.4 g/t gold.

Mali

Production at Randgold Exploration Ltd.'s Syama mine in Mali was estimated at 5 t in 1998. The other owners of Syama are the Government of Mali (20%) and the International Finance Corporation (IFC) (15%). According to Randgold, production at Syama could increase to 7 t/y within two years.

Anglo American Corporation of South Africa Limited started production at the Sadiola gold mine in early 1997. Production at Sadiola increased from its 1997 level of 11 t to 15.5 t in 1998. Its reserves are estimated at 50 Mt grading 2 g/t gold. Anglo American Corporation and International African Mining Gold Corporation (IamGold) each own 38% of the project, while the Government of Mali and the IFC own 18% and 6%, respectively.

Latin America and Mexico

Currently, there are several international companies pursuing gold mining projects in Latin America, particularly in Peru, Chile and Mexico. South America's gold output could increase from its 1997 level of nearly 310 t to around 350 t/y by the year 2000.

Peru

In 1998, Peru remained Latin America's largest gold producer with a 13% production increase to 85 t. Peru's production is expected to exceed 100 t/y by the year 2000. About 20 t of Peru's gold production was derived from placer operations.

The Yanacocha open-pit heap leaching mine of Newmont Gold Corporation (51%), Compania Minera Condessa (44.3%) and the IFC (5%) remained South America's largest gold mine in 1998 with a production level of 41 t at a cash operating cost of around US$100/oz. Total reserves at Yanacocha are estimated at around 600 t of gold.

Barrick Gold Corporation is expected to start production at the Pierina mine in 1999. The heap leaching operation is expected to have a production capacity of 23 t/y at an initial cash cost of US$50/oz.

Brazil

Brazil's 1998 gold production decreased by 6% to 56 t. Mining companies accounted for approximately 65% (36 t) of production in 1998, while the Garimpeiros' (artisanal miners) share of output continued to decline to 35% (20 t).

The sharp decline in the Garimpeiros' production from its peak of 90 t in 1989 is mainly due to the depletion of easily accessible alluvial gold deposits, more stringent environmental regulations, and restricted land access to certain regions, particularly in the Amazon. The number of Garimpeiros, which was estimated at one million in 1989 when Brazilian gold production peaked at 101 t, has declined to less than 300 000 in 1998.

Production by the Companhia Vale do Rio Doce (CVRD), Brazil's largest gold producer, was expected to reach 20 t in 1998. Currently, the Igarape Bahia mine is the company's largest gold mine with an output of 10 t of gold in 1998.

TVX Gold Inc. owns portions of two Brazilian operations. It has a 50% share in the Crixas mine and a 49% share in the Brasilia mine, which is the second largest gold operation in Brazil. TVX and its partner Rio Tinto Limited invested US$65 million to increase production at Brasilia to 8 t/y beginning in 1998.

Chile

Chile's 1998 gold production decreased by 5% to around 50 t. Approximately 6 t, or 15%, of Chile's gold production was as a by-product of copper mining.

Barrick announced that the Pascua mine will produce an estimated 25 t/y of gold starting in 2001. Barrick also operates the El Indio and Tambo mines, which produced an estimated 8 t in 1998.

Teck Corporation and Anglo American Corporation announced that they will produce around 10 t/y of gold at the Lobo-Marte mine by the year 2000.

Mexico

Gold production in Mexico increased by 1 t to 27 t in 1998. As with other Latin American countries, Mexico's gold production outlook is fueled by foreign investment.

Currently, Industrias Peñoles SA de CV is Mexico's largest gold producer with an output of 7 t/y. The La Cienega mine is Mexico's largest gold mine with an estimated output of 3 t/y.

Several projects are also expected to come on stream within the next few years. Metallica Resources Inc. and Cambior inc. are currently finalizing the feasibility study at the Cerro San Pedro gold-silver project.

Venezuela

Venezuela's gold production, estimated at 20 t in 1997, was mostly attributed to placer mining by several small private miners. State-owned Minerven is currently Venezuela's largest gold producer with an estimated output of 7 t/y.

Minera Las Cristinas (MINCA), which is 70% owned by Placer Dome Inc. and 30% owned by state-owned Corporacion Venezolana de Guyana, announced that construction at the Las Cristinas gold mine will start upon completion of financing. MINCA, which discovered Las Cristinas in 1992, has spent a total of US$110 million on this project to date. Total proven and probable ore reserves at Las Cristinas are 326 Mt grading 1.1 g/t gold. Once in production, the Las Cristinas mine is expected to produce 15 t/y of gold.

Argentina

Argentina's gold production increased to around 20 t/y from 3 t/y following production start-up at the Bajo de la Alumbrera copper-gold mine. Bajo de la Alumbrera is owned by M.I.M. Holdings Limited (50%), North Limited (25%) and Rio Algom Limited (25%). Bajo de la Alumbrera has reserves of 581 Mt grading 0.67 g/t gold and 0.52% copper. The project is expected to have an average production level of 20 t/y over a 20-year period.

Amsa, a subsidiary of Anglo American Corporation and Perez Companac, brought on stream the Cerro Vanguardia mine in 1998. The US$180 million project is expected to produce 6.5 t/y of gold.

Guyana

Production at the Omai gold mine in 1998 was 10 t. Total reserves at Omai are 50 Mt grading 1.4 g/t gold. Omai Gold Mines Limited is owned by Cambior (65%), Golden Star Resources Ltd. (30%) and the Guyana government (5%).

CONSUMPTION AND USES

Total world fabrication demand for gold in 1998 decreased by about 3% to reach 3770 t. Gold jewellery demand has doubled in the past 10 years; it exceeded total world production of gold by 665 t in 1998. World gold jewellery manufacturing decreased by about 4% to 3200 t in 1998.

Other important sectors where gold is in demand include electronics, dentistry and coinage. World demand from the electronics sector in 1998 remained stable at around 200 t. Japan accounts for nearly 40% of fabrication in this sector. World gold fabrication of coins in 1998 reached its highest level in seven years with an increase of 26% to around 120 t. The coinage market is subject to volatility from gold speculative trends and commemorative coin issues. Dentistry fabrication was stable at around 70 t, with Japan accounting for 30% of that market.

India is by far the world's largest and fastest-growing consumer of gold, increasing 20% in one year to reach 800 t in 1998. Other major gold consumers include the United States, 400 t (+17%), and China, 200 t (-9%).

Gold demand in Asian countries is being dampened by the Asian monetary crisis. As a result of the Asian financial crisis and the resulting liquidity problems faced by countries such as South Korea and Indonesia, several tonnes of gold originating mostly from the jewellery sector were melted to generate foreign

exchange earnings. Major decreases in gold consumption were registered in South Korea, -175 t (-250%); Indonesia, -65 t (-170%); and Japan, -80 t (-28%). Other factors that also negatively influenced the gold price in 1998 were the strength of the U.S. dollar, speculation, and forward sales by gold producers.

The Royal Canadian Mint produces the gold Maple Leaf bullion coins. Since its introduction in 1979, the Maple Leaf coin program has consumed some 548 t of gold, or 22.5% of total Canadian gold production during that period. In 1998 the gold Maple Leaf coin (20.9 t) ranked second in terms of world sales behind the U.S. Eagle coin (53 t).

Canada's gold fabrication demand increased to around 44 t in 1998 from 40 t in 1997. The increase was attributable to a major increase in sales of gold Maple Leaf coins from 16.7 t in 1997 to 20.9 t in 1998, its highest level since 1991. Apart from coin production, gold fabrication demand in Canada in 1998 was: jewellery, 22 t; electronics, 0.5 t; and dentistry and other industrial uses, 0.5 t. It is estimated that jewellery consumption in Canada stood at 20 t in 1998.

OUTLOOK

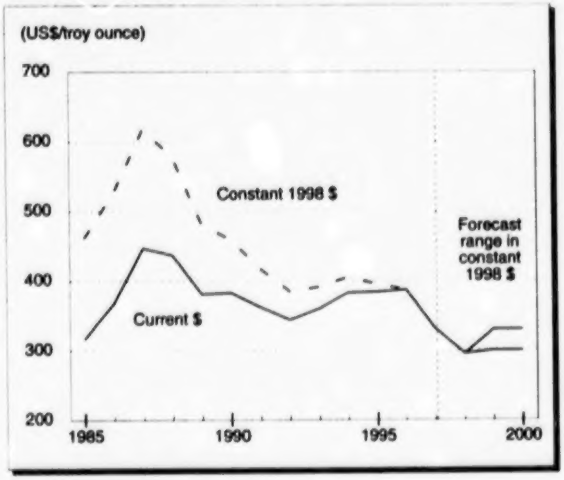
The world's current economic growth, low inflation rates, relatively stable political climate and low prices should help growth in demand for gold fabrication continue. The gap between fabrication demand and production in 1998 was 665 t. The creation of the European Central Bank (ECB) is expected to have a positive impact on the gold market because sales by member states will now have to be approved by the ECB. However, the Swiss National Bank's plan to sell over half of its gold reserves will require the approval of Swiss citizens. The potential Swiss sale of 2600 t and gold sales by other central banks and private institutions would dampen future price increases. With total central bank gold holdings of over 34 000 t, representing approximately 25% of all the gold that has ever been produced, the role of gold as a monetary instrument needs to be redefined.

In 1999, a 1% increase in total gold fabrication demand is anticipated with the jewellery sector being responsible for most of that growth. The current low real interest rates and prices are positive for the gold fabrication market.

In 1999, an average gold price of US$300/troy oz is forecast, compared to $294/oz in 1998 and $331/oz in 1997. In the medium term, the combined effect of increased demand for gold products, particularly in the jewellery sector, along with a stabilization of world gold production, should result in some strengthening in the price of gold. For the years 2000 and 2001, an average annual gold price of between US$300 and $330/oz (in constant 1998 dollars) is forecast.

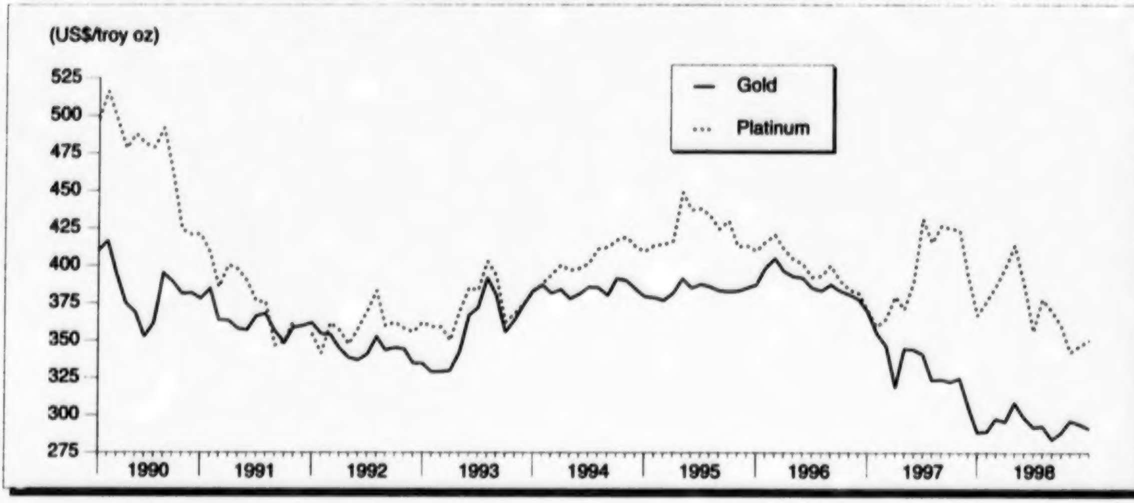
Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of February 15, 1999.

Figure 3
Gold Prices, Annual Average, 1985-2000



Source: Natural Resources Canada.

Figure 4
Precious Metal Prices, Monthly Averages, 1990-98



Sources: London Bullion Market Association; Johnson Matthey Public Limited Company.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EU MFN	Japan[1] WTO
71.08	Gold (including gold plated with platinum) unwrought or in semi-manufactured forms, or in powder form						
	Non-monetary:						
7108.11.00	Powder	Free	Free	Free	Free	0.8%	Free
7108.12.00	Other unwrought forms	Free	Free	Free	Free	Free	Free
7108.13	Other semi-manufactured forms						
7108.13.10	Of 10 carats or more	Free	Free	Free	Free	Free	Free
7108.13.20	Of less than 10 carats	4%	Free	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999; Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of the European Union (38th Annual Edition: 1998); Customs Tariff Schedules of Japan, 1998.
[1] WTO rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADA, GOLD PRODUCTION AND TRADE, 1997 AND 1998

Item No.		1997		1998p	
		(kilograms)	($000)	(kilograms)	($000)
PRODUCTION					
	Newfoundland	2 858	42 121	1 392	19 468
	Prince Edward Island	–	–	–	–
	Nova Scotia	–	–	–	–
	New Brunswick	260	3 829	266	3 725
	Quebec	37 192	548 174	37 966	530 879
	Ontario	80 569	1 187 504	84 028	1 174 967
	Manitoba	8 182	120 598	x	x
	Saskatchewan	4 124	60 787	x	x
	Alberta	12	176	–	–
	British Columbia	17 513	258 123	21 736	303 937
	Yukon	6 659	98 150	5 705	79 767
	Northwest Territories	14 110	207 968	3 845	53 771
	Total	171 479	2 527 430	166 087	2 322 417
	Mine output	171 376	. .	163 083	. .
EXPORTS					
2600.00[1]	Gold in ores and concentrates	6 010	68 406	5 654	55 201
7108.11	Gold powder				
	United States	2 683	36 583	8 543	118 124
	Total	2 683	36 583	8 543	118 124
7108.12	Other unwrought forms				
	United States	156 129	2 344 599	145 440	2 057 697
	Switzerland	6 310	92 765	25 487	349 150
	Hong Kong	18 055	226 637	6 255	82 052
	South Korea	8 109	118 625	2 943	41 549
	United Kingdom	16	267	1 081	14 661
	Germany	7 451	110 810	983	13 887
	Saudi Arabia	–	–	998	13 636
	Australia	–	–	980	13 542
	China	502	4 988	487	6 778
	Japan	2 239	33 844	498	6 714
	Taiwan	9 530	143 605	486	6 686
	Panama	–	–	112	1 628
	Other countries	606	8 620	9	95
	Total	208 947	3 124 760	185 759	2 608 075
7108.13	Other semi-manufactured forms				
	United States	6 254	85 468	30 485	392 715
	France	235	3 630	77	1 143
	United Kingdom	83	1 251	23	346
	Portugal	105	1 579	–	–
	Total	6 677	91 928	30 585	394 204
	Total refined gold exports	224 317	3 321 677	230 541	3 175 604
IMPORTS[2]					
2600.00[3]	Gold in ores and concentrates	3 337	39 070	4 435	48 775
7108.11	Gold powder				
	United States	6	73	6	72
	Italy	4	38	. . .	7
	United Kingdom	. . .	3	. . .	1
	Germany	1	18	–	–
	Ghana	55	590	–	–
	Total	66	722	6	80

TABLE 1 (cont'd)

Item No.		1997		1998p	
		(kilograms)	($000)	(kilograms)	($000)
IMPORTS (cont'd)					
7108.12	Other unwrought forms				
	United States	47 310	697 818	73 304	824 807
	Guyana	13 900	190 104	14 752	186 514
	Suriname	1 042	16 110	6 273	78 463
	United Kingdom	356	4 613	3 021	41 792
	South Korea	–	–	1 991	26 714
	Panama	4 724	16 442	7 222	21 105
	Cuba	–	–	818	8 504
	South Africa	71	936	630	8 125
	Dominican Republic	7 381	21 346	3 048	7 908
	China	–	–	410	5 448
	Venezuela	–	–	433	4 505
	Costa Rica	350	5 218	332	4 337
	Congo	–	–	113	1 420
	Other countries	7 356	103 005	239	1 291
	Total	82 490	1 055 591	112 586	1 220 934
7108.13	Other semi-manufactured forms				
	United States	685	10 477	660	9 109
	Ecuador	196	1 697	227	2 391
	Peru	–	–	192	1 790
	Switzerland	87	1 157	101	1 418
	Italy	3	51	124	929
	Other countries	2	61	14	181
	Germany	8	102	6	111
	United Kingdom	16	220	–	–
	Total	997	13 765	1 324	15 929
	Total refined gold imports	86 890	1 109 148	116 351	1 285 718

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed; p Preliminary; r Revised.
[1] Includes HS classes 2603.00.82, 2607.00.82, 2608.00.82, 2616.10.82 and 2616.90.82. [2] Imports from "Other countries" may include re-imports from Canada. [3] Includes HS classes 2603.00.00.82, 2604.00.00.82, 2607.00.00.82, 2608.00.00.82, 2616.10.00.82 and 2616.90.00.20.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, GOLD PRODUCTION BY SOURCE, 1975, 1980 AND 1985-98

Year	Auriferrous Quartz Mines		Placer Operations		Base-Metal Ores		Total	
	(kg)	(%)	(kg)	(%)	(kg)	(%)	(kg)	(%)
1975	37 530	73.0	335	0.6	13 569	26.4	51 433	100.0
1980	31 929	63.1	2 060	4.0	16 632	32.9	50 620	100.0
1985	67 241	76.8	3 464	4.0	16 857	19.2	87 562	100.0
1986	83 197	80.9	2 802	2.7	16 900	16.4	102 899	100.0
1987	94 723	81.8	4 009	3.5	17 086	14.8	115 818	100.0
1988	112 404	83.4	4 879	3.6	17 530	13.0	134 813	100.0
1989	138 211	86.6	5 354	3.4	15 930	10.0	159 494	100.0
1990	147 355	88.0	3 993	2.4	16 025	9.6	167 373	100.0
1991	153 859	87.8	3 834	2.2	17 589	10.0	175 282	100.0
1992	141 965	88.5	3 469	2.2	14 917	9.3	160 351	100.0
1993	137 346	89.7	3 787	2.5	11 997	7.8	153 129	100.0
1994	133 018	90.8	3 714	2.5	9 696	6.6	146 428	100.0
1995	132 834	88.0	5 303	3.5	12 730	8.4	150 867	100.0
1996	147 052	89.3	3 971	2.4	13 636	8.3	164 660	100.0
1997	155 543	90.7	3 987	2.3	11 949	7.0	171 479	100.0
1998p	149 391	89.9	2 983	1.8	13 714	8.2	166 089	100.0

Source: Natural Resources Canada.
p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 3. WORLD MINE PRODUCTION OF GOLD, 1980 AND 1990-97

Country	1980	1990	1991	1992	1993	1994	1995	1996	1997
					(tonnes)				
South Africa	675.1	605.1	601.1	614.1	619.5	583.9	522.4	494.6	489.0
Canada[1]	50.6	167.4	175.3	160.4	153.1	146.4	150.9	164.7	171.5
United States	30.5	294.2	296.0	329.1	332.1	326.0	319.0	329.3	351.4
Other Africa									
Ghana	10.8	17.3	27.3	33.3	41.4	44.5	52.7	50.7	55.7
Zimbabwe	11.4	17.9	19.1	19.9	20.7	22.5	26.1	26.7	24.3
Other	11.0	35.3	43.5	48.1	49.2	50.9	52.1	51.0	60.8
Total, other Africa	33.2	70.5	89.9	101.3	111.3	117.9	130.9	128.4	140.8
Latin America									
Peru	5.0	14.6	15.1	18.0	27.4	39.3	57.4	64.8	74.8
Brazil	35.0	84.1	78.6	76.5	75.7	73.4	67.4	64.2	59.1
Chile	9.3	33.3	33.0	39.3	38.5	43.3	48.5	56.4	52.9
Mexico	5.9	9.6	8.5	10.4	11.1	13.9	20.3	24.5	36.1
Venezuela	1.0	14.2	13.2	11.7	11.2	13.7	17.1	19.9	21.0
Colombia	17.0	32.5	30.7	29.9	26.4	25.5	24.1	23.1	20.6
Bolivia	2.0	10.4	10.0	7.9	12.1	14.7	16.0	15.2	15.8
Guyana	–	2.5	2.8	3.4	10.0	11.7	8.8	11.4	13.5
Ecuador	0.7	10.0	9.2	8.6	8.1	7.6	10.6	12.2	10.5
Other	15.6	9.1	9.0	9.2	8.6	8.9	11.9	12.8	20.7
Total, Latin America	91.5	220.3	210.1	214.9	229.1	252.0	282.1	304.4	312.1
Asia									
Indonesia	2.1	17.6	24.4	45.9	52.2	55.3	74.1	92.1	101.4
Papua New Guinea	14.3	33.6	60.8	71.2	61.5	60.5	54.9	53.0	49.9
Philippines	22.0	37.2	30.5	27.2	29.8	31.0	29.4	31.1	33.8
Japan	6.7	7.3	8.3	8.9	9.4	9.6	9.2	8.6	8.7
Other	5.0	12.7	14.6	16.2	18.6	19.4	20.5	20.9	22.4
Total, Asia	50.1	108.4	138.6	169.4	171.5	175.8	188.1	205.7	216.2
Europe	11.8	35.2	32.2	25.3	25.1	26.4	28.1	27.9	32.5
Oceania									
Australia	17.0	244.2	236.2	243.5	247.3	254.9	253.5	288.8	311.4
Other	1.0	10.1	10.3	14.3	15.0	14.1	14.9	16.3	15.5
Total, Oceania	18.0	254.3	246.5	257.8	262.3	269.0	269.0	305.1	326.9
Total, Western World	960.8	1 755.4	1 789.7	1 872.3	1 904.0	1 898.0	1 890.5	1 960.1	2 040.6
Other countries									
C.I.S.	. .	270.0	252.0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Russia	. .	. .	. .	151.7	164.5	158.1	142.1	130.0	137.0
Uzbekistan	. .	. .	. .	64.5	66.6	64.4	63.6	71.0	81.7
Other C.I.S.	. .	. .	. .	13.5	17.6	20.0	21.2	22.0	32.9
China	. .	93.6	103.9	112.2	119.4	120.7	132.6	144.6	156.8
North Korea	. .	13.0	13.0	17.0	15.0	14.0	14.0	13.3	9.4
Mongolia	. .	1.0	0.8	1.0	1.4	2.1	4.9	5.3	8.9
Total, other countries	. .	377.6	369.7	359.9	384.5	379.3	378.4	386.2	426.9
Total, world production	. .	2 133.0	2 159.4	2 232.2	2 288.5	2 276.7	2 268.9	2 346.3	2 467.3

Source: Consolidated Gold Fields PLC, "Gold 1997."
– Nil; . . Not available; n.a. Not applicable.
1 Production figures for Canada were obtained from Natural Resources Canada.

TABLE 4. CANADA, GOLD PRODUCTION, AVERAGE VALUE AND PERCENT OF TOTAL MINERAL PRODUCTION, 1975, 1980 AND 1985-98

Year	Total Production	Total Value	Average Value[1]	Gold as a Percent of Total Mineral Production
	(kg)	($000)	($/g)	(%)
1975	51 433	270 830	5.27	2.0
1980	50 620	1 165 416	23.02	3.7
1985	87 562	1 219 653	13.93	2.7
1986	102 899	1 689 292	16.42	5.2
1987	115 818	2 204 472	19.03	6.1
1988	134 813	2 331 989	17.30	6.3
1989	159 494	2 315 860	14.52	5.9
1990	167 373	2 407 654	14.38	5.9
1991	175 282	2 338 614	13.34	6.7
1992	160 351	2 141 161	13.35	6.0
1993	153 129	2 284 991	14.92	6.2
1994	146 428	2 448 926	16.86	6.0
1995	150 867	2 557 502	16.95	5.9
1996	164 660	2 799 547	17.00	5.6
1997	171 479	2 527 429	14.74	5.0
1998p	166 089	2 322 417	13.98	5.2

Source: Natural Resources Canada.
p Preliminary.
[1] Value is based on average London p.m. fix price for gold.

TABLE 5. GOLD FABRICATION IN DEVELOPED AND DEVELOPING COUNTRIES, 1980 AND 1991-97

Fabricated Gold	1980	1991	1992	1993	1994	1995	1996	1997
					(tonnes)			
DEVELOPED COUNTRIES								
Carat jewellery	318	883	925	892	890	901	891	956
Electronics	93	140	129	139	148	161	162	182
Dentistry	63	51	55	54	55	59	59	62
Other uses	58	57	60	60	62	64	65	63
Medals and fake coins	18	9	6	4	4	3	2	3
Official coins	170	121	77	98	58	70	47	83
Subtotal	719	1 261	1 252	1 247	1 217	1 258	1 227	1 349
DEVELOPING COUNTRIES								
Carat jewellery	196	1 474	1 833	1 660	1 720	1 866	1 916	2 372
Electronics	2	65	46	41	42	44	45	56
Dentistry	2	12	11	10	9	8	8	8
Other uses	4	16	25	39	41	44	46	50
Medals and fake coins	3	18	23	21	23	32	32	40
Official coins	21	22	16	19	22	14	16	16
Subtotal	228	1 607	1 953	1 790	1 857	2 008	2 063	2 542
TOTAL								
Carat jewellery	514	2 357	2 758	2 552	2 610	2 767	2 807	3 328
Electronics	95	205	175	180	190	205	207	238
Dentistry	65	63	66	64	64	67	67	70
Other uses	62	67	85	99	103	108	111	113
Medals and fake coins	21	27	29	25	27	38	34	43
Official coins	191	143	93	117	80	84	63	99
Total	946	2 866	3 206	3 037	3 074	3 269	3 290	3 891

Source: Consolidated Gold Fields PLC, "Gold 1997."
Note: Numbers may not add to totals due to rounding.

TABLE 6. AVERAGE ANNUAL GOLD PRICES, 1934-98, AND MONTHLY, 1994-98

Year	US$/oz	C$/oz	Year	US$/oz	C$/oz
1934-67	35	. .	1983	423.52	521.82
1968	38.82	41.82	1984	360.63	466.99
1969	41.13	44.29	1985	317.35	433.21
1970	35.97	37.54	1986	367.58	510.73
1971	40.87	41.27	1987	446.66	592.18
1972	58.22	57.66	1988	436.45	554.76
1973	97.22	97.24	1989	381.27	451.33
1974	158.80	155.36	1990	383.72	447.79
1975	160.96	163.76	1991	362.34	415.09
1976	124.78	123.01	1992	343.86	415.23
1977	147.80	157.10	1993	360.06	464.35
1978	193.51	220.74	1994	384.15	524.60
1979	305.69	358.12	1995	384.07	526.94
1980	614.38	719.08	1996	387.69	528.62
1981	459.22	550.57	1997	328.41	454.52
1982	375.52	463.51	1998	294.11	435.77

Month	1994		1995		1996		1997		1998	
	(US$/oz)	(C$/oz)	(US$/oz)	(C$/oz)	(US$/oz)	(C$/oz)	(US$/oz)	(C$/oz)	(US$/oz)	(C$/oz)
January	387.14	509.53	378.74	535.16	398.70	545.02	355.03	479.65	289.26	416.53
February	381.66	518.66	376.75	527.45	404.92	556.77	346.43	469.41	297.74	425.77
March	384.00	523.87	381.82	537.22	396.35	540.62	318.76	437.02	295.87	420.14
April	377.91	522.70	391.34	538.88	392.87	533.91	344.71	480.53	308.56	441.24
May	381.18	526.06	385.23	523.91	391.99	536.63	344.10	474.86	298.95	430.49
June	385.71	533.63	387.62	534.14	385.25	526.25	340.83	471.71	292.22	426.64
July	385.45	532.98	386.14	525.54	383.46	525.34	323.78	445.52	292.89	436.41
August	380.21	524.14	383.50	519.64	387.51	531.66	324.00	450.03	284.23	434.87
September	391.37	529.95	382.93	517.72	383.29	524.72	322.62	447.15	288.67	438.78
October	390.16	526.82	383.20	515.79	380.91	514.23	324.85	450.24	296.48	456.58
November	384.38	524.32	385.21	521.19	377.85	505.56	306.35	432.57	294.24	453.13
December	379.48	526.91	387.44	530.02	369.34	502.67	288.78	412.09	291.34	448.66

Source: London Bullion Market Association, a.m. fix, as compiled by Natural Resources Canada.
. . Not available.

Gypsum and Anhydrite

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GYPSUM

Canadian shipments of natural gypsum totalled 8.1 Mt valued at $87.9 million in 1998, based on preliminary data. This compares to 8.6 Mt valued at $95.3 million in 1997, based on final data. The decrease in shipments of natural gypsum of about 6% resulted from weaker levels of construction activity in Canada as well as from a decrease in exports to the United States, according to preliminary statistics from Statistics Canada. In addition to shipments of natural gypsum, shipments of commercial-quality, synthetic flue-gas derived (FGD) gypsum from coal-fired generating stations are estimated to be about 350 000 t/y.

The Canadian Industry

Most gypsum producers in Canada are closely integrated in both mining and wallboard manufacturing. Six companies operate 12 mines and 13 wallboard plants with a total of about 1900 employees. The major gypsum mining and related production plants are listed in Table 2.

In Atlantic Canada, Nova Scotia accounts for nearly 80% of Canada's output of natural gypsum and nearly all of its exports (Table 1). Most gypsum deposits being mined in the Atlantic provinces are characterized by their high quality, amenability to inexpensive mining methods, and close access to coastal bulk-shipping facilities.

In Newfoundland, Lafarge Canada Inc. arranged to purchase, in late 1998, the gypsum reserves owned by Atlantic Gypsum Resources, Inc. and the wallboard manufacturing plant owned by affiliate Atlantic Gypsum Limited, a division of Atlantic Group Limited. (The Lafarge group of companies became directly involved in the North American gypsum business in 1996 with an acquisition in the United States of two plants from Georgia-Pacific Corp.)

In addition to the manufacture of wallboard, Newfoundland gypsum is used as a set regulator in cement by North Star Cement Ltd.

CGC Inc. continued to operate the gypsum fibre board plant in Port Hawkesbury, Nova Scotia. This plant was purchased from Louisiana Pacific Corporation in 1997. Natural gypsum is purchased locally, perlite is imported, and large quantities of recycled paper are backhauled, mainly from the United States. (This project was the first in Atlantic Canada to manufacture gypsum board products for both regional and export markets.)

Technical evaluation and environmental assessment continued at the new gypsum occurrence owned by Tusket Mining Limited at a new gypsum deposit situated at Murchyville in central Nova Scotia. Possible reserves of more than 300 Mt have been delineated at the site, which is located about 60 km from Sheet Harbour.

In Quebec, there is no production of natural or commercial-quality synthetic gypsum. CGC continued to use synthetic gypsum at its Montréal wallboard plant, which is now capable of using desulphogypsum from its $11 million facility at Belledune, New Brunswick. (This facility was built in cooperation with New Brunswick Power Corporation.)

In Ontario, two underground mines remain in operation. All of Ontario's production of natural gypsum is now used on site since Westroc Industries Limited closed its mine at Drumbo in 1995. Westroc now uses 100% synthetic gypsum, provided under a long-term contract with Ontario Power Generation Inc. (formerly Ontario Hydro) to maintain output of wallboard at its Mississauga, Ontario, plant. This contract is for approximately 200 000 t/y of desulphogypsum from Hydro's Lambton facility, which is the site of the first flue-gas desulphurization (FGD) system at a thermal-electric generating station in Ontario.

In western Canada, production of natural gypsum from Amaranth in Manitoba and from Windermere

(Elkhorn II deposit) and Canal Flats in British Columbia serve the Prairie region and a portion of the B.C. market not served by imports. The Georgia-Pacific Corporation (GPC) plant in Surrey, British Columbia, meets most of its requirements for natural gypsum under a long-term contract with a 49%-owned Mexican affiliate.

Several companies continue to use recycled gypsum wallboard in their production processes. The newly acquired GPC wallboard plant located in Surrey, British Columbia, was the first in North America to use large quantities. This was possible through arrangements with a reclaimer, New West Gypsum, now based in Oakville, Ontario. Up to one fifth of the raw material needs of some plants in Canada include recycled material – a combination of about 75% scrap from new construction sites (post-construction material) and 25% waste from wallboard plants. Westroc currently recycles about 20 000 t and 30 000 t of board annually at its Vancouver and Mississauga plants, respectively.

World Developments and Trade

World reserves of gypsum are widespread and large; North American reserves are estimated to be more than 1.5 billion t. World production of gypsum in 1998 was an estimated 104.7 Mt, based mainly on an estimate by the U.S. Geological Survey (refer to the Office of Minerals Information web site at http://www.usgs.gov). The United States ranked number one with 19.0 Mt, followed by Thailand (8.6 Mt), Iran (8.5 Mt) and Canada (8.1 Mt). Shipments of wallboard by U.S. producers were 2.5 billion m^2, based on estimates made in late 1998. (This amount is approximately 6% more than the previous year.)

U.S. imports of gypsum from Spain amounted to more than 1.0 Mt in 1998, mainly because of relatively low east-to-west backhaul freight rates. Canada's imports of gypsum from Mexico, as described earlier, as well as those from the United States, are used by both wallboard and cement manufacturers. Imports from Spain, however, are used only by specific cement manufacturers.

The Canadian International Trade Tribunal (CITT) concluded in early 1998 that normal values and export prices now prevail for gypsum board originating in or exported from the United States. As a result of this ruling, anti-dumping duty liabilities have been discontinued.

Major developments in the United States continue to influence primarily North American consumption of natural gypsum and synthetic gypsum. These developments include: a new USG Corporation wallboard plant in Pennsylvania utilizing synthetic gypsum as well as reclaimed paper to be on stream in 2000; a new Lafarge Corporation wallboard plant in Kentucky, near Cincinnati, using synthetic gypsum and reclaimed paper, also to be on stream in 2000; a new National Gypsum wallboard plant in Pennsylvania, using synthetic gypsum; and new plants by Georgia Pacific Corp. in Georgia and by Standard Gypsum in Tennessee. Other new plants and expansions are also planned early in the new century.

Processing and Markets

In North America, wallboard manufacturing accounts for an estimated 75% of gypsum use, cement processing accounts for 10-15%, and agriculture and industrial processes account for the remainder. In general, the wallboard industry serves the residential, institutional and commercial building sectors. In the United States, an estimated 4.6 Mt/y of synthetic FGD gypsum is consumed as a complete or partial substitute for natural gypsum in the manufacture of wallboard, according to the U.S. Geological Survey. U.S. shipments of wallboard in 1998 were at near-full capacity, amounting to about 27 billion ft^2 (2.5 billion m^2), a record for the industry, according to the Washington-based Gypsum Association (GA). (Canadian wallboard plants operated at a capacity of about 3.77 billion ft^2 (350 million m^2), also according to the GA.) Housing starts have become a less reliable indicator of the demand for gypsum wallboard because this product's improved fire-retarding qualities, as well as increased renovation activity, have encouraged its more general use.

The Portland cement industry requires crushed, non-calcined gypsum, acting as a set regulator in a proportion up to 5% by total weight, ground with the primary stage cement clinker to produce the final cement product. Based on this proportion of gypsum, the total amount required by cement producers in Canada is estimated to be about 600 000 t/y.

For agricultural purposes, specifications mainly relate to the degree of fineness. Gypsum combines with potassium-aluminum silicates in the soil, resulting in the release of potassium for use as a nutrient. Gypsum also serves to reduce sub-soil acidity, which is particularly beneficial in aluminum-rich lateritic soils. In addition, it provides a source of calcium and sulphur trioxide, and helps break up hard soils, allowing better aeration and water penetration and retention.

For filler uses, gypsum is dried and finely ground to a range of particle sizes for use in joint compounds (mainly with gypsum wallboard), plastics, paint and paper. Relatively pure uncalcined gypsum, depending on glass batch chemistry, may also substitute for salt cake (sodium sulphate) in glass manufacturing. Special high-purity gypsum may be used in foods and pharmaceutical products.

The increased use of lime/limestone FGD technology, along with the implications relating to industrial minerals, prompted a cooperative project by Natural Resources Canada (NRCan) and the former U.S. Bureau of Mines (now the Office of Minerals Information, U.S. Geological Survey) to produce a bibliography on the subject. A free copy of *Flue Gas Desulfurization and Industrial Minerals: A Bibliography*, which has more than 4000 references covering the period 1982 through June 1993, can be obtained from NRCan or the U.S. Geological Survey.

ORTECH International plans its Sixth International Conference on Flue-Gas Desulphurization and Synthetic Gypsum in Toronto in May 2000. This series of conferences has contributed greatly to improving communication and the dissemination of new information among power utilities and other synthetic gypsum producers, consumers and equipment suppliers.

Prices

Prices for gypsum in merchant markets are negotiated among buyers and sellers, and published figures have little relevance. In the United States, average prices for crude material, f.o.b. mine, were about US$7.10/t during the five-year period from 1994 to 1998, according to preliminary information from the U.S. Geological Survey.

Outlook

Canadian shipments of gypsum in 1999 are expected to increase moderately because of an increase in construction activity. Housing starts in Canada were 125 000 in 1996, 149 000 in 1997, and about 137 000 in 1998. Based on information from the Canada Mortgage and Housing Corporation, housing starts are forecast to be about 145 000 in 1999. With real economic growth in both Canada and the United States expected to continue, the outlook continues to be positive in the office and industrial building sectors.

Housing starts in the United States are expected to stabilize following a 10% increase in 1998. However, total construction is expected to remain firm based on relatively high consumer confidence and strength in repair and renovation work, as well as office construction.

Although new construction materials are being introduced, demand for gypsum wallboard is expected to remain popular because of its low price, ease of installation, and well-recognized fire-retarding properties. Diverse uses relating to building plasters, Portland cement, fillers and pigments, soil conditioners, and fertilizers as a diluent are important and tend to expand with overall economic growth. The present structure of the industry in Canada is not expected to change much, although the future availability of synthetic gypsum resulting from more strenuous emission controls will influence developments in some areas. The recycling of scrap and waste gypsum from construction sites and wallboard manufacturing lines will continue to become more important in both Canada and the United States.

ANHYDRITE

Production and trade statistics for anhydrite are included with gypsum. Anhydrite, the anhydrous form of gypsum (about twice as hard and also denser than gypsum), is produced by Fundy Gypsum Company at Wentworth, Nova Scotia, and by Little Narrows Gypsum Company at Little Narrows, Nova Scotia.

Shipments of anhydrite in 1997 were 180 100 t for all uses, based on final figures; similarly, shipments in 1998 were an estimated 139 763 t, according to the Nova Scotia Department of Natural Resources. These shipments were mainly to the United States for use as a peanut crop fertilizer and for manufacturing Portland cement. Smaller quantities were shipped to Quebec and Ontario for the production of cement.

Test work on the use of anhydrite in floor screed and suspended floor systems, which had been carried out as part of a Canada-Nova Scotia cooperative mineral development agreement, showed promise as new uses for Canadian gypsum. Similarly, testing on the use of anhydrite (in combination with water and special chemicals) as a mine "pack" construction material to improve underground support in coal mines has been encouraging.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of January 30, 1999.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2520.10	Gypsum; anhydrite	Free	Free	Free	Free
68.09	Articles of plaster or of compositions based on plaster: Boards, sheets, panels, tiles and similar articles, not ornamented				
6809.11	Faced or reinforced with paper or paperboard only				
6809.11.10	Gypsum wallboard	6%	Free	Free	Free
6809.11.90	Other	6%	Free	Free	Free
6809.19.00	Other	6.5%	3%	Free	Free
6809.90	Other articles				
6809.90.10	Models and casts, of a kind used in the manufacture of dental prosthesis	Free	Free	Free	Free
6809.90.90	Other	6.5%	3%	Free	Free

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999.

TABLE 1. CANADA, GYPSUM PRODUCTION AND TRADE, 1996-98

Item No.		1996		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
PRODUCTION (shipments)							
	Crude gypsum						
	Nova Scotia	6 578 674	67 668	6 851 977	74 108	6 415 343	67 762
	Ontario	x	x	x	x	x	x
	Manitoba	x	x	x	x	x	x
	British Columbia	x	x	x	x	x	x
	Newfoundland	x	x	x	x	x	x
	Total[1]	8 201 774	85 415	8 627 772	95 263	8 094 532	87 972
IMPORTS							
2520.10	Gypsum, anhydrite						
	United States	114 537	4 261	111 472	6 736	82 403	5 268
	Mexico	132 163	1 603	109 290	1 768	14 084	1 681
	China	29	2	20	10	9	11
	Indonesia	–	–	–	–	10	11
	Other countries	479	34	132	25	85	17
	Total	247 208	5 900	220 914	8 539	96 591	6 988
2520.20	Gypsum; anhydrite; plasters						
	United States	32 932	8 819	31 540	8 981	38 216	12 341
	Japan	34	36	30	25	60	43
	Italy	27	8	11	7	47	40
	United Kingdom	–	–	11	3	31	23
	New Zealand	–	–	–	–	18	15
	Other countries	84	72	136	54	92	43
	Total	33 077	8 935	31 728	9 070	38 464	12 505
		(square metres)		(square metres)		(square metres)	
6809.11	Plasterboards, etc., not ornamental; faced or reinforced with paper or paperboard						
	United States	. .	509	. .	2 340	. .	3 039
	United Kingdom	. .	124	. .	97	. .	108
	Other countries	. .	15	. .	34	. .	4
	Total	. .	648	. .	2 471	. .	3 151
6809.19	Plasterboards, etc., not ornamental; faced or reinforced, n.e.s.						
	United States	. .	3 466	. .	4 414	. .	6 622
	Mexico	–	–	. .	2	. .	22
	Taiwan	. .	11	. .	17	. .	19
	France	–	–	. .	. .	. .	18
	Other countries	. .	5	. .	167	. .	18
	Total	. .	3 482	. .	4 600	. .	6 699

TABLE 1 (cont'd)

Item No.		1996		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)							
6809.90	Articles of plaster or compositions based on plaster, n.e.s.						
	United States	. .	3 804	. .	3 973	. .	4 248
	Mexico	. .	326	. .	430	. .	814
	China	. .	553	. .	655	. .	684
	United Kingdom	. .	848	. .	757	. .	615
	Thailand	. .	124r	. .	70	. .	194
	Germany	. .	4	. .	3	. .	118
	Italy	. .	14	. .	36	. .	33
	Other countries	. .	150	. .	173	. .	110
	Total	. .	5 823r	. .	6 097	. .	6 816
	Total imports of gypsum and gypsum products	. .	24 788r	. .	30 777	. .	36 159
EXPORTS							
2520.10	Gypsum, anhydrite						
	United States	5 486 553	61 739	5 934 326	75 489	5 560 769	70 909
	Denmark	39 347	409	20 892	528	22 029	477
	Venezuela	–	–	26 415	255	–	–
	Other countries	110	83	341	124	–	–
	Total	5 526 010	62 231	5 961 974	76 396	5 582 798	71 386
2520.20	Gypsum; anhydrite; plasters						
	United States	2 567	1 209	1 247	840	1 444	1 184
	Bermuda	42	12	–	–	40	27
	Japan	35	56	24	12	23	21
	France	16	10	36	10	23	11
	Other countries	248	182	43	45	–	–
	Total	2 908	1 469	1 350	907	1 530	1 243
		(square metres)		(square metres)		(square metres)	
6809.11	Plasterboards, etc., not ornamental; faced or reinforced with paper or paperboard						
	United States	78 135 664	139 989	93 679 180	176 880	102 086 319	225 314
	France	–	–	–	–	43 332	130
	Cuba	59 234	147	30 623	123	48 100	121
	Barbados	13 100	36	18 110	43	73 501	116
	Bermuda	2 500	5	–	–	40 230	107
	Trinidad and Tobago	–	–	10 610	27	29 405	85
	Israel	–	–	–	–	33 064	70
	Chile	–	–	98 000	198	17 500	44
	Russia	11 963	33	4 800	16	18 809	42
	Portugal	73 425	74	37 765	76	10 600	27
	Netherlands Antilles	–	–	–	–	3 962	10
	Saint Pierre and Miquelon	6 894	18	–	–	3 600	9
	Other countries	207 985	299	101 427	538	–	–
	Total	78 510 785	140 601	93 980 515	177 901	102 408 482	226 077
6809.19	Plasterboards, etc., not ornamental; faced or reinforced, n.e.s.						
	United States	. .	13 462	. .	15 148	. .	21 338
	Italy	–	–	–	–	. .	162
	United Kingdom	. .	74	. .	90	. .	65
	Chile	–	–	–	–	. .	57
	Bermuda	–	–	. .	54	. .	39
	Netherlands	–	–	–	–	. .	24
	Other countries	. .	454	. .	283	–	–
	Total	. .	13 990	. .	15 575	. .	21 685
6809.90	Articles of plaster or compositions based on plaster						
	United States	. .	10 284	. .	16 886	. .	20 190
	Bahamas	–	–	–	–	. .	443
	Israel	. .	5	–	–	. .	198
	New Zealand	. .	39	. .	103	. .	154
	China	–	–	–	–	. .	126
	Other countries	. .	2 152	. .	1 163	. .	232
	Total	. .	12 480	. .	18 152	. .	21 343
	Total exports of gypsum and gypsum products	. .	230 771	. .	288 931	. .	341 734

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; n.e.s. Not elsewhere specified; p Preliminary; x Confidential.
1 Totals do not include gypsum produced or shipped for use by Canadian Portland cement producers.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, GYPSUM MINING AND GYPSUM PRODUCTS MANUFACTURING OPERATIONS, 1998

Company	Location	Operation
NEWFOUNDLAND		
Lafarge Gypsum Canada Inc.	Fischells Brook	Open-pit mining
	Corner Brook	Wallboard manufacture
NOVA SCOTIA		
CGC Inc.	Port Hawkesbury	Fibre-gypsum board manufacture
Fundy Gypsum Company	Wentworth and Miller Creek	Open-pit mining of gypsum and anhydrite
Georgia-Pacific Corporation	Sugar Camp	Open-pit mining
Georgia-Pacific Corporation	McKay Settlement	Open-pit mining
Little Narrows Gypsum Company	Little Narrows	Open pit mining of gypsum and anhydrite
National Gypsum (Canada) Ltd.	Milford	Open-pit mining
NEW BRUNSWICK		
Westroc Industries Limited	McAdam	Wallboard manufacture
QUEBEC		
CGC Inc.	Montréal	Wallboard manufacture
	St-Jerome	Wallboard plant mothballed
Georgia-Pacific Corporation	Montréal	Distribution terminal only
Westroc Industries Limited	Montréal	Wallboard manufacture
ONTARIO		
CGC Inc.	Hagersville	Underground mining and wallboard manufacture
Georgia-Pacific Corporation	Caledonia	Underground mining and wallboard manufacture
Westroc Industries Limited	Clarkson	Wallboard manufacture
MANITOBA		
Georgia-Pacific Corporation	Amaranth	Open-pit mining
	Winnipeg	Wallboard manufacture
Westroc Industries Limited	Amaranth	Open-pit mining
	Winnipeg	Wallboard manufacture
ALBERTA		
Georgia-Pacific Corporation	Edmonton	Wallboard manufacture
Westroc Industries Limited	Calgary	Wallboard manufacture
BRITISH COLUMBIA		
Georgia-Pacific Corporation	Canal Flats	Open-pit mining
	Vancouver	Gypsum products manufacture
Westroc Industries Limited	Vancouver	Gypsum products manufacture
	Windermere	Open-pit mining

Source: Natural Resources Canada.

TABLE 3. CANADA, GYPSUM PRODUCTION, TRADE AND CONSUMPTION, 1975, 1980 AND 1985-98

	Production[1]	Imports[2]	Exports	Apparent Consumption[3]
		(tonnes)		
1975	5 719 451	553 338	3 691 676	2 581 113
1980	7 336 000	154 717	4 960 240	2 530 477
1985	7 760 783	121 802	5 879 664	2 002 921
1986	8 802 805	221 644	5 921 982	3 102 467
1987	9 093 926	217 625	5 704 853	3 606 698
1988[e]	8 813 760	274 917	5 651 286	3 437 391
1989	8 179 588	291 373	5 357 055	3 113 906
1990	7 977 665	318 114	5 757 327	2 538 472
1991	6 727 221	259 863	4 940 193	2 046 891
1992	7 294 700	260 505	5 010 649	2 544 556
1993	7 563 369	280 581	5 315 618	2 528 332
1994	8 587 303	292 156	5 942 572	2 936 887
1995	8 054 741	177 327	5 565 427	2 666 641
1996	8 201 774	247 208	5 526 010	2 922 972
1997	8 627 772	220 914	5 981 974	2 866 712
1998[p]	8 094 532	96 591	5 582 798	2 608 325

Sources: Natural Resources Canada; Statistics Canada.
[p] Preliminary.
[e] Beginning in 1988, imports and exports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Imports and exports include HS class 2520.10.00 (gypsum, anhydrite).
[1] Producers' shipments of crude gypsum. [2] Includes crude and ground, but not calcined. [3] Production plus imports minus exports.

TABLE 4. CANADA, VALUE OF CONSTRUCTION BY TYPE, 1994-96

	1994	1995	1996
		($ millions)	
BUILDING CONSTRUCTION			
Residential	34 922	29 186	32 575
Industrial	3 006	3 243	4 227
Commercial	6 251	6 265	6 945
Institutional	4 931	4 982	4 906
Other	1 948	2 095	2 360
Total building	51 058	45 770	51 013
ENGINEERING CONSTRUCTION			
Marine	492	445	447
Transportation	6 032	6 436	5 874
Waterworks	904	1 140	1 358
Sewage, dams, sanitary systems	1 501	1 585	1 397
Electric power	3 965	3 441	2 934
Railway, telephones	1 446	1 298	1 880
Gas and oil facilities	13 721	13 474	12 891
Other	2 325	2 803	2 495
Total engineering	30 386	30 621	29 276
Total construction	81 444	76 391	80 289

Sources: Natural Resources Canada; Statistics Canada, catalogue no. 61-223 (additional information is also available on the Internet at http://www.statcan.ca/english/Pgdb/Economy/Manufacturing/manuf18.htm or http://www.cmhc-schl.gc.ca/Mktinfo/store/#nho).
Notes: Numbers may not add to totals due to rounding. Expenditures include value of new construction as well as major renovation work purchased.

TABLE 5. WORLD PRODUCTION OF GYPSUM, 1997 AND 1998

	1997	1998e
	(000 tonnes)	
Canada	8 600	8 100
Australia	2 100	2 200
China	7 800	8 000
France	5 000	5 000
Iran	8 500	8 500
Japan	5 500	5 500
Mexico	5 900	5 900
Spain	7 400	7 400
Thailand	8 600	8 600
United Kingdom	2 000	2 000
United States	18 600	19 000
Other countries	24 100	24 500
Total world	104 100	104 700

Sources: Natural Resources Canada; U.S. Geological Survey, January 1999.
e Estimated.

Iron Ore

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International Developments

After a strong start in 1998, world iron ore production declined during the second half of the year to reach a total of 1051 Mt for the year, or to about the same level as in 1997. Were it not for strong growth in the production of low-grade natural iron ore in China, which increased by close to 18 Mt, world production would have declined by over 2%. International trade in iron ore more accurately reflects the situation in 1998. According to the UNCTAD Trust Fund Project for Iron Ore Information, exports decreased 2.5% to 458.3 Mt in 1998 from the 470.2 Mt reached in 1997. Brazil is on the verge of catching up with Australia as the major iron ore exporting country with exports totalling 143 Mt in 1998, representing an increase of 3 Mt over the previous year. The Asian crisis seems to have hit Australia harder with that country's exports dropping by 11 Mt to 144 Mt. Japan remains the largest importer of iron ore (121 Mt), followed by China (52 Mt), Germany (45 Mt) and South Korea (34 Mt). As a result of the Asian crisis, imports declined significantly in Asia (a total of 14 Mt for the three countries noted above). In contrast, imports in Europe increased by more than 7 Mt, reflecting the favourable situation in the iron ore market at the beginning of the year.

Canadian Developments

Developments in the Canadian iron ore industry mirrored the international situation. After a strong start, Canadian shipments of iron ore declined during the second half of 1998 to reach a total of 38.9 Mt, or to about the same level reached in 1997. Exports dropped by almost 2 Mt to 30.2 Mt, with the largest decreases occurring in the U.S. and German markets. Canadian production consists basically of pellets, sinter and concentrates. In 1998, shipments of agglomerated products and concentrates totalled 26.9 Mt and 12.1 Mt, respectively. Three mining operations in the Labrador Trough, a major geological belt extending through northern Quebec and Labrador, account for over 98.7% of Canadian production. These mines belong to the Iron Ore Company of Canada (IOC), Quebec Cartier Mining Company (QCM), and Wabush Mines. The remainder of Canada's production comes from the now closed Algoma Ore Division (AOD) of Algoma Steel Inc., located in Wawa, Ontario, and from by-product recovery of magnetite from two base-metal smelters in British Columbia, the latter being used in coal processing. QIT Fer et Titane Inc., whose operations are not included in statistics on iron ore, mines ilmenite, an iron-titanium ore, near Havre-Saint-Pierre. This ore is processed in the Sorel area, where pig iron is recovered as a by-product of titanium slag.

In October, IOC announced that it was considering a major investment project totalling $344 million. Part of the project would involve re-opening the Sept-Îles pelletizing plant at a cost of $255 million. The project should enable IOC to increase its annual pellet production by 4.5 Mt at a capital cost per tonne produced that is considered to be among the lowest in the world. This announcement follows another expansion project that was responsible for increasing the annual pellet production capacity of the Carol Lake plant from 10 Mt to 12.5 Mt. In April, a new five-year collective agreement was signed by the company and the United Steelworkers of America. Ratification of this collective agreement was one of the necessary conditions for the $344 million investment program announced by IOC. In February 1999, the company began mining the Luce satellite deposit near Labrador City, which contains more than one billion tonnes of crude ore grading 39% iron. During its first year of operation, Luce should produce close to 6 Mt of crude ore; production is expected to increase to 15 Mt/y within the next four years and to eventually reach 25 Mt/y of crude ore. Mitsubishi Corporation has elected to exercise its option to acquire a further 3.2% of IOC, as agreed when North Limited, of Australia, purchased a majority interest in IOC in April 1997. The option gave Mitsubishi the right to acquire a further 3.2% interest from North at the same price paid by North. Under the new share-

holding arrangement, IOC is owned 56.1% by North Limited, 25.0% by Mitsubishi, 6.9% by Dofasco, and 12% by the Labrador Iron Ore Royalty Fund.

QCM's iron ore shipments decreased slightly in 1998. One reason was the delayed re-opening of a blast furnace by one of its main U.S. clients. The loss of these shipments, combined with the weak market during the second half of the year, forced the company to take steps to adjust its production level accordingly. QCM suspended overtime and, in December, called a two-week shut-down of the Mount Wright mine and concentrator and a three-week shut-down of its pelletizing plant and port activities at Port-Cartier. QCM invested a total of $10 million to convert one of its pellet lines to produce low silica- and manganese-grade pellets for use in direct reduction furnaces. At the beginning of 1998, CAEMI of Brazil, one of two shareholders in QCM, indicated that it was considering the idea of conducting a feasibility study on the construction of a new pelletizing plant for its QCM subsidiary that would have an annual capacity of 4 Mt. The idea was put forward early in the year at a time when the market for iron pellets was relatively solid. CAEMI estimated the cost of such a plant at $400 million. If the project goes ahead, mining capacity will have to be increased in order to maintain the current sales level of concentrates, which is approximately 8 Mt/y. The new plant could be dedicated to producing low silica-grade pellets for use in direct reduction furnaces. No decision on this study will be made until QCM presents its 25-year mine plan to its shareholders around the middle of 1999. On a related matter, QCM has initiated studies to assess the potential for expanding reserves at Mount Wright and to rehabilitate the Fire Lake deposit. This deposit was previously mined by Sidbec-Normines, which ceased production in 1983. The studies were undertaken with the objective of identifying resources that could enable the company to replace existing reserves at Mount Wright that are expected to be depleted by the year 2008. It is estimated that the development of new reserves at Mount Wright will involve removing almost 30 million m^3 of waste rock, which could cost approximately $300 million over a 10-to-15-year period.

In late 1998, in an effort to recover some of the fines produced during handling of pellets before they are loaded on ships, Wabush Mines built an $8 million screening facility at its Pointe-Noire pelletizing plant. Wabush produces relatively coarse pellets, and abrasion causes fines to be produced and mixed with the ore to be shipped. The commissioning of this plant, combined with a number of modifications to the grinding circuit, will enable Wabush Mines to improve the quality of its products by reducing the fines to less than 1% of the tonnage of iron ore shipped. The company is also evaluating the opportunity to increase its pellet production capacity to 7.5 Mt/y, which would enable it to produce new value-added products such as low silica- and manganese-grade pellets for use in direct reduction furnaces. It also initiated a feasibility study to evaluate the potential for producing ferromanganese. Another feasibility study was conducted on the possibility of carrying out dredging operations at Point-Noire in order to accommodate larger-capacity vessels and thereby gain access to new markets in Europe and the Far East.

As announced previously, Algoma Steel Inc. ceased its mining activities at its Algoma Ore Division located near Wawa, Ontario, in June 1998. This closure comes after almost 59 years of mining that began in 1939. During this period, siderite ore production came from an underground mine and an open pit, although the latter was shut down in 1970. The deposit was first put into production in 1889, and mining operations lasted a few years. During its years in production, the Algoma Ore Division generated over 105 Mt of iron ore, primarily in the form of self-fluxing sinter. In the future, Algoma Steel Inc. will get its iron ore supply from the Tilden Mining Co., a company in which it holds 45% of the shares. The mine closure resulted in the loss of 220 jobs in the town of Wawa.

Prices

The relative strength of the iron ore market at the beginning of 1998, during the period when prices are negotiated on the European and Japanese markets, enabled mining companies to obtain price increases ranging from 2.8% to 3.1%. At that time, these price increases, following three years of increases, were considered to be too small to allow producers to attain 1991 and 1992 price levels. In the second half of the year and at the beginning of 1999, the significant decline in the market for steel gave steel producers the negotiating tools they needed to demand significant price reductions for 1999. Iron ore producers were the only link in the steel production chain to achieve a positive balance sheet. Iron ore producers, including those in Canada, had to accept significant price decreases for 1999 ranging from 11% to 14% during negotiations with Japanese and European clients. In combination with reduced ore shipments, these price decreases are expected to contribute to a marked deterioration in the profitability of Canadian producers. If bad market conditions remain unchanged, iron ore producers might have to offer further discounts in prices already negotiated with some of their clients.

Outlook

Any change in the economic situation in Asia is expected to have a marked impact on the steel market and, consequently, on that of iron ore. China is

expected to continue to look to foreign markets to satisfy a large part of its iron ore requirements. Chinese imports of iron ore rose from 14.3 Mt in 1990 to over 55 Mt in 1997, representing an annual growth rate of over 18%. The development of a more modern market economy in China and the demand for higher-quality products is expected to lead to the closure of the country's more marginal iron ore deposits and China is therefore expected to maintain or increase its present level of exports.

If market conditions remain unchanged from the second half of 1998, Canadian shipments of iron ore are expected to drop significantly in 1999 to possibly 34 Mt. QCM and Wabush mines have announced temporary closures during July and August, respectively. Rather than halting production for a specific period of time, IOC plans to reduce its production capacity. Over the longer term, the three Canadian producers are contemplating a number of expansion projects that could increase Canada's production capacity to 50 Mt/y.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of May 31, 1999.

TABLE 1. CANADA, IRON ORE PRODUCTION AND TRADE, 1997 AND 1998

Item No.		1997		1998p	
		(tonnes) [1]	($000)	(tonnes) [1]	($000)
PRODUCTION (mine shipments)					
	By province				
	Newfoundland	21 847 537	921 893r	23 265 706	942 794
	Quebec	16 549 790r	x	15 152 000	x
	Ontario	430 295r	x	388 728	x
	British Columbia	100 233r	2 201 025r	101 837	2 177
	Total [2]	38 927 855r	1 571 741r	38 908 271	1 584 146
	By product				
	Concentrates	12 037 061	295 817	12 126 192	314 192
	Pellets	26 460 499	1 258 019	26 393 351	1 253 799
	Sinter	430 295	17 905	388 728	16 175
	Total [2]	38 927 855	1 571 741	38 908 271	1 584 146
IMPORTS					
2601.11	Iron ore concentrates, non-agglomerated				
	Brazil	154 573	7 157	149 675	7 790
	Mexico	–	–	47 083	2 536
	South Africa	41	1	55 718	2 312
	United States	32 831r	968r	44 675	1 130
	Chile	3	. . .	20 000	849
	Russia	–	–	54	2
	Tanzania	4	. . .	35	1
	China	5	. . .	4	. . .
	Germany	180	6	7	. . .
	Peru	2	. . .	3	. . .
	Sweden	–	–	2	. . .
	Guinea	–	–	2	. . .
	Australia	–	–	21	. . .
	Guyana	–	–	2	. . .
	Venezuela	2 279	65	–	–
	Japan	190	4	–	–
	Mauritania	46	1	–	–
	Turkey	27	1	–	–
	Greenland	14	. . .	–	–
	Ireland	9	. . .	–	–
	France	8	. . .	–	–
	United Kingdom	7	. . .	–	–
	Ghana	2	. . .	–	–
	Total	190 221r	8 203r	317 281	14 620
2601.12	Iron ore, agglomerated				
	United States	6 306 963	315 846	6 606 367	354 510
	Brazil	509 495	24 988	257 136	13 599
	South Africa	2	. . .	20 117	1 760
	France	–	–	63	3
	Chile	–	–	2	. . .
	Mexico	50 560	3 118	–	–
	Venezuela	50 094	2 104	–	–
	Mali	23	1	–	–
	United Kingdom	4	. . .	–	–
	Norway	2	. . .	–	–
	Total	6 917 143r	346 057r	6 883 685	369 872

TABLE 1 (cont'd)

Item No.		1997		1998p	
		(tonnes)[1]	($000)	(tonnes)[1]	($000)
EXPORTS					
2601.11	Iron ore concentrates, non-agglomerated				
	United Kingdom	2 524 558	65 032	2 227 048	62 234
	Netherlands	1 607 459	39 871	1 885 726	54 763
	France	1 768 933	42 240	2 057 034	52 865
	Germany	2 523 619	71 029	1 837 818	52 532
	South Korea	944 662	23 109	828 221	23 738
	Japan	998 359	22 637	788 283	22 710
	United States	621 651r	14 790r	688 535	18 009
	Philippines	379 672	8 492	333 312	8 590
	China	298 476	7 235	144 993	3 505
	Spain	116 845	2 760	–	–
	Belgium	92 502	2 465	–	–
	Total	11 876 736r	299 660r	10 790 970	298 946
2601.12	Iron ore, agglomerated				
	United States	9 279 852r	424 629r	7 831 667	408 198
	United Kingdom	2 362 004	115 345r	2 076 886	108 792
	Netherlands	2 228 277	106 249	2 107 823	107 336
	Germany	1 702 742	80 579	1 676 258	84 973
	Belgium	751 478	35 949	1 404 711	69 618
	Italy	1 491 564	72 559	1 094 427	54 915
	Australia	628 991	31 364	642 718	33 094
	France	559 495	26 117	622 005	27 658
	China	531 336	25 421	604 456	26 592
	South Korea	546 923	26 369	519 274	24 481
	Taiwan	101 540	4 653	370 026	19 178
	Turkey	42 312	1 970	149 384	7 754
	Portugal	191 804	9 361	126 698	6 436
	Spain	–	–	78 068	4 142
	Switzerland	–	–	61 939	2 957
	Norway	44 769	2 166	22 048	1 171
	Total	20 463 087r	962 741r	19 388 388	987 295
	Total exports, all classes				
	United States	9 901 503	439 429	8 520 202	426 207
	United Kingdom	4 886 562	176 662	4 303 934	171 026
	Germany	4 226 361	151 608	3 993 549	162 099
	Netherlands	3 835 736	146 120	3 514 076	137 505
	Italy	1 491 564	72 558	2 679 039	80 523
	France	2 323 428	68 357	1 404 711	69 618
	South Korea	1 491 585	49 477	1 094 427	54 915
	Belgium	843 980	38 413	1 347 495	48 219
	China	829 812	32 655	642 718	33 094
	Australia	628 991	31 363	749 449	30 097
	Japan	998 359	22 636	788 283	22 710
	Portugal	191 804	9 361	370 026	19 178
	Philippines	379 672	8 491	333 312	8 590
	Taiwan	101 540	4 653	149 384	7 754
	Spain	116 845	2 760	126 698	6 436
	Norway	44 769	2 166	78 068	4 142
	Turkey	42 312	1 969	61 939	2 957
	Mexico	–	–	22 048	1 171
	Total	32 334 823	1 258 678	30 179 358	1 286 241
Consumption of iron ore at Canadian iron and steel plants		14 359 000	. .	14 236 000	. .

Sources: Natural Resources Canada; Statistics Canada; American Iron Ore Institute.
– Nil; . . Not available; . . . Amount too small to be expressed; p Preliminary; r Revised; x Confidential.
1 Dry tonnes for production (shipments) by province; natural weight for imports and exports. 2 Total iron ore shipments include shipments of by-product iron ore.

TABLE 2. CANADA, IRON ORE SHIPMENTS, 1994-98

Company and Location	Ore Mined	Product Shipped	1994	1995	1996	1997	1998p
			(000 tonnes, natural or wet)				
Algoma Ore Division Algoma Steel Inc. Wawa, Ontario	Siderite	Sinter[1]	788	997	733	795	651
Iron Ore Company of Canada Carol Lake, Labrador	Specular hematite and magnetite	Concentrate	5 475	4 634	4 038	4 811	5 173
		Acid pellets	6 547	3 121	2 430	2 725	2 436
		Fluxed pellets	3 484	7 084	8 075	8 820	8 713
		Chips	–	188	169	–	–
Loadstone Limited	Magnetite	Concentrate	–	–	300	100	–
Quebec Cartier Mining Company Mount Wright, Quebec	Specular hematite	Concentrate	8 206	7 759	7 264	7 159	6 852
		Acid pellets	3 763	4 884	2 521	7 795	3 559
		Fluxed pellets	3 379	3 449	5 481	4 324	4 418
		Low Si pellets	1 025	–	51	225	280
Wabush Mines Wabush, Labrador and Pointe-Noire, Quebec	Specular hematite and magnetite	Acid pellets	3 035	3 322	3 155	5 697	5 845a
		Fluxed pellets	1 670	1 866	2 158	. .	. .
		Concentrate	369	135	–	. .	. .
		Chips	2	105	24	–	–
British Columbia producers	Magnetite	Concentrate	74	83	88	100	102
Total			37 817	37 627	36 486	38 551	38 029

Source: Natural Resources Canada.
– Nil; . . Not available; p Preliminary.
a Includes acid pellets, fluxed pellets and low Si pellets.
[1] Includes about 400 000 t of iron-bearing material not from the mine.

TABLE 3. RECEIPTS, CONSUMPTION AND INVENTORIES OF IRON ORE AT CANADIAN IRON AND STEEL PLANTS, 1997 AND 1998

	1997	1998
	(000 tonnes)	
Receipts imported	7 745	6 655
Receipts from domestic sources	6 748	7 360
Total receipts at iron and steel plants	14 493	14 015
Consumption of iron ore	14 359	14 236
Inventory at docks, plants, mines and furnace yards, December 31	9 010	9 968
Inventory change	-404	958

Source: American Iron Ore Association.

TABLE 4. WORLD IRON ORE PRODUCTION, 1996-98

	1996	1997	1998
	(000 tonnes, natural)		
China	250 510	255 000	273 000
Brazil	179 870	187 950	191 000
Australia	154 560	165 660	155 000
Russia	72 140	70 860	72 300
India	67 260	69 400	69 000
United States	62 130	62 800	61 000
Ukraine	47 750	52 993	50 760
Canada	35 690	38 928	38 908
South Africa	30 830	33 230	33 000
Sweden	21 290	21 900	20 900
Venezuela	18 720	17 559	16 370
Mauritania	11 200	11 700	11 400
Kazakstan	12 800	12 626	7 430
Other countries	57 791	55 144	51 250
Total	1 022 541	1 055 750	1 051 318

Sources: Natural Resources Canada; Interfax; UNCTAD Trust Fund Project on Iron Ore Information.

TABLE 5. SELECTED PRICES OF IRON ORE DESTINED FOR JAPAN AND EUROPE, SELECTED YEARS, 1986-99

Ore	Market	Source	1986	1988	1990	1992	1994	1996	1998	1999
			(US¢/Fe Unit Dmt, f.o.b.)							
Fines (including concentrate)	Europe	CVRD	26.26	23.50	30.80	33.10	26.47	30.00	31.00	27.59
		Iscor	22.70	20.55	24.75	. .	20.60	23.10	24.01	. .
		Kiruna	27.90	26.00	35.70	36.50	28.10	32.70	34.10	29.55
		Carol Lake	26.50	23.69	31.78	33.15	26.15	30.00	30.90	27.20
		Mt. Wright	26.50	23.69	31.78	33.15	26.15	30.00	30.90	27.20
	Japan	CVRD	23.29	20.90	27.38	28.11	22.65	25.89	26.89	23.99
		Iscor	20.23	17.75	23.62	23.86	19.21	21.55	20.65	19.93
		Hamersley[2]	25.56	23.31	30.54	31.35	25.26	28.33	29.45	26.21
		Carol Lake	22.09	19.93	26.11	27.26	21.96	24.63	25.60	22.79
Lump	Europe	Iscor	26.70	22.34	33.00	32.29	28.00	32.13	32.13	. .
		Hamersley[1]	36.20	36.00	49.97	48.28	40.28	46.82	47.94	40.75
	Japan	CVRD	23.29	21.89	29.22	29.00	24.38	27.63	28.44	22.37
		Iscor	23.53	21.86	30.21	29.79	25.74	30.02	30.91	30.50
		Hamersley[2]	29.81	27.88	38.53	38.23	32.74	37.09	38.18	34.28
Pellets	Europe	CVRD	35.60	40.35	51.60	48.47	43.64	52.40	53.56	46.46
		Kiruna	38.15	46.35	59.00	53.48	45.60	55.80	57.20	48.70
		Carol Lake	36.50	39.95	52.58	49.35	44.00	53.80	54.88	47.15
		Mt. Wright	36.50	39.95	52.58	49.35	44.00	53.80	54.88	47.15
	Japan	CVRD (Nibrasco)	34.73	37.93	48.50	45.57	41.03	49.26	50.34	43.68
		Savage River	35.45	35.89	45.90	43.12	38.83	46.62	47.65	41.33

Sources: *The Tex Report; Skillings Mining Review*; UNCTAD.
. . Not available; Dmt Dry metric tonne; f.o.b. Free on board.
[1] c.i.f. Rotterdam; [2] f.o.b. Dampier.
Note: Price is reported in cents, U.S. currency, for each percentage point of iron in a tonne of ore, e.g., at 30¢/Fe unit, ore grading 65% iron would bear a price of 65 x 30¢ = US$19.50/t.

Lime

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"Lime" is a general term referring to burned or calcined limestone (burnt lime or quicklime) and its secondary products, including slaked lime and hydrated lime (or calcium hydroxide). In the calcining process, quicklime (CaO or CaO.MgO) begins to form when the dissociation temperature of the limestone occurs. Temperatures are maintained sufficiently long until there is a complete breakdown of the limestone and a release of the carbon dioxide content. High-calcium quicklime containing mainly CaO and less than 5% MgO is the most common type of lime produced. However, dolomitic quicklime (or dolime) as well as its hydrated products are also produced; these products contain 35-40% MgO.

Canadian Industry

The lime industry in Canada comprises 20 operating plants, of which 12 plants were in eastern Canada (Table 3). Total employment in the industry in 1997 (the most recent year for which data are available) was approximately 812, about 10% more than in 1996. Calcining capacity to produce quicklime did not change; the effective capacity utilization rate was approximately 70%.

Canadian shipments of all lime in 1998 amounted to 2.51 Mt valued at $221 million based on preliminary data. Quicklime accounted for about 90% of the total volume, essentially the same ratio as in 1997. Production figures do not include some captive production from pulp and paper plants that burn sludge to recover lime for re-use in the causticization process. Similarly, beginning with 1996 data, General Chemical Canada Ltd. has not been included as a producer of lime. Changes in ownership continued in the industry.

In 1997, Redland Quarries Inc. of Dundas, Ontario, came under new ownership following the acquisition of its parent company, U.K.-based Redland plc, by Lafarge SA of France. The final stage of Redland Quarries' acquisition by Lafarge's U.S. affiliate, Lafarge Corporation, was completed in mid-1998. The Dundas plant now operates as Lafarge Lime (Canada) Inc. Ownership of this plant is now controlled by joint-venture partners, Carmeuse SA of Belgium and Lafarge SA of France, following a later agreement that combined these companies' lime operations in North America.

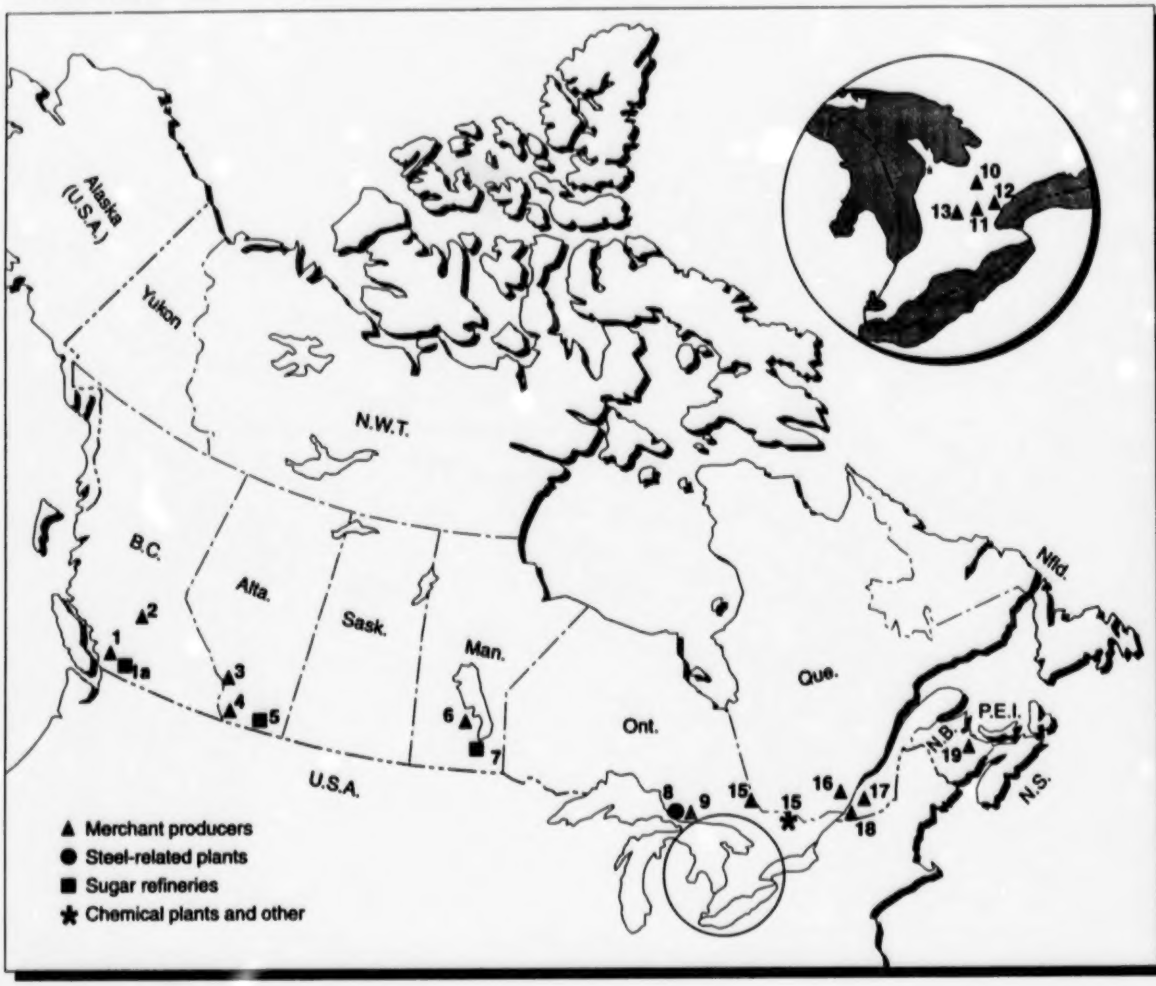
Oglebay Norton Co., of Cleveland, Ohio, purchased Global Stone Corp. of Oakville, Ontario, for approximately $250 million based on a cash offer for Global's common shares. With this purchase, Oglebay now owns Global Stone Ingersoll Ltd., a major Ontario merchant lime producer.

Graymont Limited, of Vancouver, British Columbia, the owner of Canadian-based companies Continental Lime Ltd. and Graybec Calc. Inc., purchased Bellafonte Lime Co. of Bellafonte, Pennsylvania, as well as Genlime Group LP of Genoa, Ohio, in mid-1998. Graymont, including its other affiliated plants in the United States, is now one of North America's major lime producers.

Consumption

High-calcium quicklime is commercially available in six forms: lump, crushed, pebble, ground, pulverized, and as briquettes or pellets. Slaked lime is produced from mixing quicklime and water, and may be purchased as a putty, dry powder or slurry. Hydrated lime is produced from slaked lime after drying and regrinding. The resulting hydrated lime products, which are categorized by their chemistry, include the following types: high-calcium lime, dolomitic lime, and magnesian or hydraulic lime. (The latter type contains siliceous, aluminous or ferrous compounds.) Aglime, or agricultural lime, refers to pulverized limestone used for soil neutralization, primarily during the fall and spring spreading seasons.

Figure 1
Lime Producers in Canada, 1998



Numbers refer to locations on map above.

MERCHANT PRODUCERS

1. Chemical Lime Company of Canada, Fort Langley
2. Continental Lime Ltd., Pavilion Lake
3. Continental Lime Ltd., Exshaw
4. Summit Lime Works Limited, Hazell
6. Continental Lime Ltd., Faulkner
9. Northern Lime Limited, Spragge
10. Guelph DoLime Limited, Guelph
11. Global Stone (Ingersoll) Ltd.
12. Lafarge Lime (Canada) Inc., Dundas
13. BeachviLime Limited, Ingersoll
15. Miller Minerals, Haileybury
16. Graybec Calc Inc., Joliette
17. Graybec Calc Inc., Marbleton
18. Graybec Calc Inc., Bedford
19. Havelock Lime, a division of Goldcorp Inc., Havelock

STEEL-RELATED PRODUCERS

8. Algoma Steel Inc., Sault Ste. Marie

SUGAR REFINERIES

1a. Rogers Sugar Ltd., Vancouver
5. Rogers Sugar Ltd., Taber
7. Rogers Sugar Ltd., Fort Garry

CHEMICAL PLANT OR OTHER

14. Timminco Limited, Haley Station

The consumption of lime produced in Canada consists of two basic categories: the captive market, which mainly includes lime produced internally by chemical plants, one steel producer, and three sugar refineries; and the merchant market, which is served by the mainstream lime producers.

The consumption of quicklime, based on sales in the merchant market, amounted to 1 593 506 t in 1997. The major end uses were steel-making (51%), environmental control (15%), pulp and paper (14%), chemicals (8%), and other industrial uses, including metal concentration (12%). Hydrated lime shipments in the merchant market amounted to 168 828 t in 1997, and were sold mainly for environmental control (54%), other industrial uses (16%), metal concentration (3%), agricultural uses (3%), masonry (4%), and other miscellaneous uses related mainly to road and soil stabilization and other construction (20%). Eastern Canada, comprising Ontario eastward, accounted for about three quarters of total merchant sales of quicklime in 1997.

Lime is used widely in the metallurgical, industrial (including environment), agricultural and construction sectors. In the metallurgical industry, lime is consumed mainly as a basic flux in steel furnaces allowing impurities, including silica, alumina, phosphorus and sulphur, to form a slag. (Other fluxing agents may include limestone, dolomite and fluorspar.) Limestone and dolomite (or dolostone) are used mainly in blast furnaces for making pig iron and in sinter plants at steel mills; limestone, lime and dolime are used in both basic oxygen and electric-arc steel furnaces.

The industrial markets for lime mainly include the pulp and paper, mining, chemicals manufacturing, and environmental control industries. The pulp and paper industry is one of the major consumers of lime, mainly for the preparation of digesting liquor for manufacturing kraft or sulphate paper, and for pulp bleaching during a primary stage of production.

In the mining sector, acidic effluents are treated with alkalis or related industrial products. These include lime, limestone, soda ash, and ammonium and magnesium hydroxide to raise pH levels (for neutralization) and to precipitate metals. In the uranium industry, lime controls the hydrogen-ion concentration in the extraction process, as well as in the recovery of sodium carbonate and for neutralization of waste sludges.

Lime is increasingly needed for environmental control because of more stringent regulations. The neutralization of lakes has attracted attention in the past; however, research conducted mainly in Ontario has shown that pure limestone (or calcite) is the most cost-effective method.

Air pollution control is a major developing market for lime and limestone in North America. Major coal-fired power stations are taking measures to reduce emissions from the burning of high-sulphur coal, oil and lignite. Several methods apply, including the use of flue gas desulphurization (FGD) units, or scrubbers. In Canada, wet scrubbing processes using limestone or lime are becoming more important.

Agricultural uses apply mainly to neutralizing soil acidity. The current practice principally involves the use of pulverized limestone (or aglime). In the case of some sandy soils, dolomitic liming is carried out to help balance magnesium deficiencies.

Miscellaneous uses for lime include sugar refining (removal of acids from the crude sugar liquids) and petroleum refining (neutralization of sulphur compounds and sulphur dioxide emissions). Lime is also used in making plaster, mortar, leather and rubber, paint, glass, dolomitic refractories, and calcium-silicate bricks.

Energy and Technology

Energy costs to produce quicklime account for about 40% of total production costs, one of the highest ratios in the mineral processing sector. Calcining takes place mainly in vertical (shaft-type) or rotary-type kilns, the latter technology being most common in North America. Preheater systems and computerized process control systems are now commonplace.

About 50% of the kilns in service use natural gas, with coal and electricity accounting for the remainder. Long rotary kiln systems, typically with no preheat capability, consume from 7 to 13 gigajoules per tonne (GJ/t) of calcined lime, according to producers. New rotary kilns, with preheaters, consume less than 5.0 GJ/t, and short, vertical shaft kilns consume about 4.2 GJ/t of calcined lime. Other types of kilns of comparatively recent design are the rotary hearth, travelling grate, fluo-solid, and inclined vibratory kiln. Dust-collecting equipment to meet current environmental control regulations is required for all systems.

Prices

Published prices for lime represent only a broad range. Actual prices vary according to marketing strategies and supply and demand. Average prices for high-calcium quicklime and high-calcium hydrated lime, f.o.b. plant, in Ontario, in bulk, were quoted at $70.80/t and $80.40/t respectively at the end of 1998.

International Developments

In 1998, world lime production was an estimated 121 Mt, compared to 120 Mt in 1997 (Table 5). The United States and China, each accounting for more than 20 Mt or about 17% of world output, were followed by Germany and Japan each with about 7% of world output.

Although Canada ranks in the top ten lime-producing countries (2.5 Mt), it is a relatively small producer because of fewer industrial requirements. However, reserves of limestone are relatively large and the proximity of lime plants to U.S. markets has resulted in a favourable balance of trade in lime products, as shown in Table 2.

The United States produced 20.4 Mt of lime in 1998 compared to 19.7 Mt in 1997, according to preliminary figures. Apparent consumption amounted to 20.6 Mt in 1998 compared to 19.9 Mt in 1997. Environmental uses for lime in the United States, which include flue gas desulphurization (FGD), water treatment and waste-water treatment, have grown rapidly and are expected to surpass use by the iron and steel industry. FGD-related uses are now the second most important use after the steel industry.

Stricter rules are now in effect concerning waste-water treatment and the use of sewer sludges. As a result, it is expected that lime consumption will increase, and that the biosolids produced will find acceptable uses as fertilizers, soil amendments, covers for landfill sites, and in mine reclamation.

Outlook

The production of lime in Canada in 1999 is expected to increase marginally based on continued strength in the pulp and paper, steel, and chemicals industries. Although demand for steel is expected to be stronger by mid-1999, according to the Canadian Steel Producers Association, increased imports of steel from outside of North America may effectively decrease domestic production and the need for lime in this sector. Canada's favourable balance of trade in lime products with the United States is expected to continue.

In the medium to longer term, demand for lime as a flux in steel-making is forecast to decline because of several factors. These include: improved efficiencies in steel production and energy inputs, the use of larger amounts of scrap in basic oxygen furnaces, improved ore grades, more use of fluxed iron ore pellets, and growth of the mini-mill sector, which makes steel from scrap iron in electric furnaces.

Consumption in the environmental sector will expand in the short term with an increase in the treatment of effluents in the industrial and mining sectors. Ontario Power Generation Inc. (formerly Ontario Hydro) has installed wet scrubbers using limestone at two of its coal-fired units at the Lambton Generating Station near Sarnia, Ontario. Similarly, limestone technology has been installed for controlling sulphur dioxide emissions at major power installations in Nova Scotia and New Brunswick. Commercial-quality synthetic gypsum has now become an important coal combustion product resulting from the installation of these scrubbers; this is referred to in detail in a separate chapter entitled *Gypsum and Anhydrite*.

The lime industry has become more concentrated as fewer companies control more operations. These companies or corporate groups (often diversified geographically and in product line) will be in a better position to meet future economic downturns. However, the current low rate of capacity utilization, along with ongoing plant modernization, will allow the lime industry to be well positioned to respond to any major increases in demand.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of February 1, 1999.

PRICES

Canadian lime prices quoted in *Camford Chemical Report*	December 1997	December 1998
	($ per tonne)	
Lime, carload and truckload		
f.o.b. Ontario plant		
High-calcium quicklime, bulk	70.80	70.80
High-calcium hydrated lime, bulk	80.40	80.40

f.o.b. Free on board.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2522.10	Quicklime	Free	Free	Free	Free
2522.20	Slaked lime	Free	Free	Free	Free
2522.30	Hydraulic lime	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999.

TABLE 1. CANADA, LIME PRODUCTION AND TRADE, 1996-98

Item No.		1996 (tonnes)	1996 ($000)	1997 (tonnes)	1997 ($000)	1998p (tonnes)	1998p ($000)
PRODUCTION[1]							
	By type						
	Quicklime	2 134 437	176 774	2 219 385	187 347	2 263 400	194 854
	Hydrated lime	267 595	25 805	257 186	25 691	250 200	25 654
	Total	2 402 032	202 579	2 476 571	213 038	2 513 600	220 509
	By province						
	New Brunswick	x	x	x	x	x	x
	Quebec	x	x	x	x	x	x
	Ontario	1 317 393	103 535	1 343 834	108 884	1 331 900	108 793
	Manitoba	x	x	x	x	x	x
	Alberta	x	x	x	x	x	x
	British Columbia	x	x	x	x	x	x
	Total	2 402 032	202 579	2 476 571	213 038	2 513 600	220 509
IMPORTS[2]							
2522.10	Quicklime						
	United States	28 575	3 416	39 204	4 741	23 327	3 244
	Other countries	54	24	18	6	15	2
	Total	28 629	3 440	39 222	4 747	23 342	3 246
2522.20	Slaked lime						
	United States	4 266	826	5 286	1 016	5 389	1 221
	Other countries	89	40	18	8	29	27
	Total	4 355	866	5 304	1 024	5 418	1 248
2522.30	Hydraulic lime						
	United States	3 643	746	2 793	589	5 166	1 235
	Belgium	–	–	53	13	58	20
	Other countries	12	2	10	6	4	2
	Total	3 655	748	2 856	608	5 228	1 257
2518.20	Calcined dolomite						
	United States	4 113	866	6 459	952	2 946	584
	Canada	–	–	–	–	143	13
	Total	4 113	866	6 459	952	3 089	597

TABLE 1 (cont'd)

Item No.		1996		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
EXPORTS							
2522.10	Quicklime						
	United States	149 664	17 852	185 996	22 515	143 541	17 476
	Chile	42	31	–	–	91	10
	Total	149 706	17 883	185 996	22 515	143 632	17 486
2522.20	Slaked lime						
	United States	21 333	2 638	36 996	4 534	27 661	3 799
	Bermuda	16	3	–	–	–	–
	China	–	–	–	–	10	3
	Total	21 349	2 641	36 996	4 534	27 671	3 802
2522.30	Hydraulic lime						
	United States	45 763	4 171	1 240	154	136	13
	Bermuda	31	6	–	–	–	–
	China	–	–	–	–	7	3
	Total	45 794	4 177	1 240	154	143	16
2518.20	Calcined dolomite						
	United States	33 827	6 346	33 620	6 390	32 515	6 459
	Venezuela	26 422	887	26 602	355	–	–
	Trinidad and Tobago	–	–	50 559	670	–	–
	Other countries	562	135	40	11	–	–
	Total	60 811	7 368	110 821	7 426	32 515	6 459

Sources: Natural Resources Canada; Statistics Canada.
– Nil; p Preliminary; x Confidential.
[1] Producers' shipments and quantities used by producers. [2] Includes re-imports.
Notes: Numbers may not add to totals due to rounding. HS code 2522.30, as interpreted, applies mainly to hydrated lime.

TABLE 2. CANADA, LIME PRODUCTION, TRADE AND APPARENT CONSUMPTION, 1970, 1975, 1980 AND 1985-98

	Production[1]					Apparent
	Quick	Hydrated	Total	Imports	Exports	Consumption[2]
			(tonnes)			
1970	1 296 590	224 026	1 520 616	30 649	181 994	1 369 271
1975	1 533 944	199 195	1 733 139	30 099	234 034	1 529 204
1980	2 364 000	190 000	2 554 000	40 901	403 166	2 191 735
1985	2 054 294	157 286	2 211 580	23 056	194 097	2 040 539
1986	2 069 043	173 534	2 242 577	46 917	189 512	2 099 982
1987	2 140 793	189 278	2 330 071	44 290	163 767	2 210 594
1988a	2 306 831	211 151	2 517 982	32 543	122 900	2 427 625
1989	2 349 312	202 622	2 551 934	39 095	83 608	2 507 421
1990	2 137 996	202 741	2 340 737	43 715	138 409	2 246 043
1991	2 184 836	190 424	2 375 260	45 012	134 405	2 285 867
1992	2 193 752	190 592	2 384 344	55 706	173 248	2 266 802
1993	2 186 749	192 247	2 378 996	52 690	190 068	2 241 618
1994	2 250 205	198 818	2 449 023	66 886	193 902	2 322 007
1995	2 244 800	216 916	2 461 716	52 884	266 475	2 248 125
1996	2 134 437	267 595	2 402 032	36 639	216 849	2 221 822
1997	2 219 385	257 186	2 476 571	47 382	224 232	2 299 721
1998p	2 263 400	250 200	2 513 600	33 988	171 446	2 376 142

Sources: Natural Resources Canada; Statistics Canada.
p Preliminary.
a Beginning in 1988, exports and imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Imports and exports include HS classes 2522.10, 2522.20 and 2522.30.
[1] Producers' shipments and quantities used by producers. [2] Production plus imports, less exports.

TABLE 3. CANADIAN LIME INDUSTRY, 1998

Company	Plant Location	Calcining Capacity	Market	Type of Quicklime and Other Products
		(000 t/y)		
NEW BRUNSWICK				
Havelock Lime, a division of GoldCorp. Inc.	Havelock	175	Merchant	High-calcium[1]
QUEBEC				
Graybec Calc Inc.	Marbleton	330	Merchant	High-calcium[1]
Graybec Calc Inc.	Joliette	200	Merchant/captive	High-calcium[1]
Graybec Calc Inc.	Bedford	200	Merchant	High-calcium
ONTARIO				
Algoma Steel Inc.	Sault Ste. Marie	200	Captive	High-calcium and dolomitic
BeachviLime Limited	Ingersoll	600	Merchant	High-calcium[1]
Miller Minerals, a division of Miller Paving Limited	Haileybury	40	Merchant	High-calcium
Guelph DoLime Limited	Guelph	100	Merchant	Dolomitic[1]
Northern Lime Limited	Spragge	200	Merchant	High-calcium
Lafarge Lime (Canada) Inc.	Dundas	345	Merchant	Dolomitic
Global Stone (Ingersoll) Ltd.	Ingersoll	215	Merchant/captive	High-calcium
Timminco Limited	Haley Station	53	Captive	Dolomitic
MANITOBA				
Rogers Sugar Ltd.	Fort Garry	16	Captive	High-calcium
Continental Lime Ltd.	Faulkner	117	Merchant	High-calcium
ALBERTA				
Rogers Sugar Ltd.	Taber	66	Captive	High-calcium
Continental Lime Ltd.	Exshaw	130	Merchant	High-calcium[1]
Summit Lime Works Limited	Hazell	50	Merchant	High-calcium and dolomitic[1]
BRITISH COLUMBIA				
Continental Lime Ltd.	Pavilion Lake	235	Merchant	High-calcium
Chemical Lime Company of Canada Inc.	Fort Langley	135	Merchant	High-calcium[1]
Rogers Sugar Ltd.	Vancouver	. .	Captive	High-calcium

Source: Natural Resources Canada.
. . Not available.
[1] Production of hydrated lime.
Note: Lantic Sugar Limited operates sugar refineries in Quebec and New Brunswick.

TABLE 4. CANADA, CONSUMPTION[1] OF DOMESTIC LIME, QUICK AND HYDRATED, 1993-97

End Uses	1993	1994	1995	1996	1997
			(tonnes)		
CHEMICAL AND INDUSTRIAL					
Steel-making	746 111	825 605	836 826	780 386	807 000
Water and sewage treatment	237 766	219 438	236 315	260 221	278 987
Water purification	62 808	69 611	57 715	46 572	52 026
Gas scrubbing	13 736	14 274	12 058	8 276	9 376
Metal concentration	125 919	120 837	146 461	144 224	151 258
Pulp and paper mills	256 770	235 746	245 007	229 659	225 363
Chemicals	77 193	136 607	194 033	129 835	125 889
Other industrial uses	102 975	152 329	178 705	82 753	74 365
CONSTRUCTION					
Road and soil stabilization	9 395	6 757	2 504	7 337	14 458
Mason and finishing lime	6 060	3 387	3 834	3 427	7 252
Other	22 114	26 191	28 194	22 401	11 851
AGRICULTURE	11 001	12 500	5 600	5 056	4 509
Total	1 671 848	1 823 282	1 947 252	1 720 147	1 762 334

Source: Natural Resources Canada, based on producing companies' surveys, 1993-97.
[1] Includes merchant market only; excludes companies that are completely captive producers/consumers.

TABLE 5. WORLD PRODUCTION OF QUICKLIME AND HYDRATED LIME, INCLUDING DEAD-BURNED DOLOMITE SOLD AND USED, 1994-98

	1994	1995	1996	1997	1998p
			(000 tonnes)		
China	19 500	20 000	20 000	20 500	21 000
United States	17 400	18 500	19 100	19 700	20 400
Japan[1]	7 710	7 900	7 676	7 850	7 800
Germany	7 500	8 000	8 000	8 000	8 000
Mexico	6 500	6 600	6 600	6 600	6 600
Brazil	5 700	5 700	5 700	5 700	5 700
Italy[2]	3 500	3 500	3 500	3 500	3 500
France	2 500	2 600	3 000	2 800	2 800
Poland	2 500	2 500	2 500	2 500	2 500
United Kingdom	2 500	2 500	2 500	2 500	2 500
Canada	2 450	2 450	2 400	2 500	2 500
Other countries	40 350	39 200	40 200	37 850	37 700
Total	118 110	119 450	121 180	120 000	121 000

Sources: Natural Resources Canada; Statistics Canada; U.S. Geological Survey.
p Preliminary.
[1] Quicklime only. [2] Includes hydraulic lime.

Magnesium

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World production of primary and secondary magnesium increased in 1997 to 427 400 t, up from a revised figure of 404 900 t in 1996, and world consumption of both primary and secondary magnesium reached 416 100 t in 1997, up from 394 500 t in 1996.

In 1998, increased demand again led the way to record magnesium shipments. According to the International Magnesium Association (IMA), primary magnesium shipments for 1998 were a record 360 300 t, up 8% over the 333 700 t shipped in 1997. The main reasons for the increase were higher shipments for the die-casting (up 16% over 1997) and aluminum alloy (up 6%) markets.

Primary Western production (which excludes China, the former Soviet Union and Israel) increased by over 11% (27 900 t) to 272 100 t, beating the 1990 record of 260 800 t. Exports from Russia, China and Ukraine continued to be strong, accounting for about 30% of Western markets in the last quarter of 1998.

IMA data also indicate that year-end inventories of magnesium increased in 1998 to total 44 300 t, compared to 32 900 t at the end of 1997. This represents approximately 39 days of world consumption.

Canadian Developments

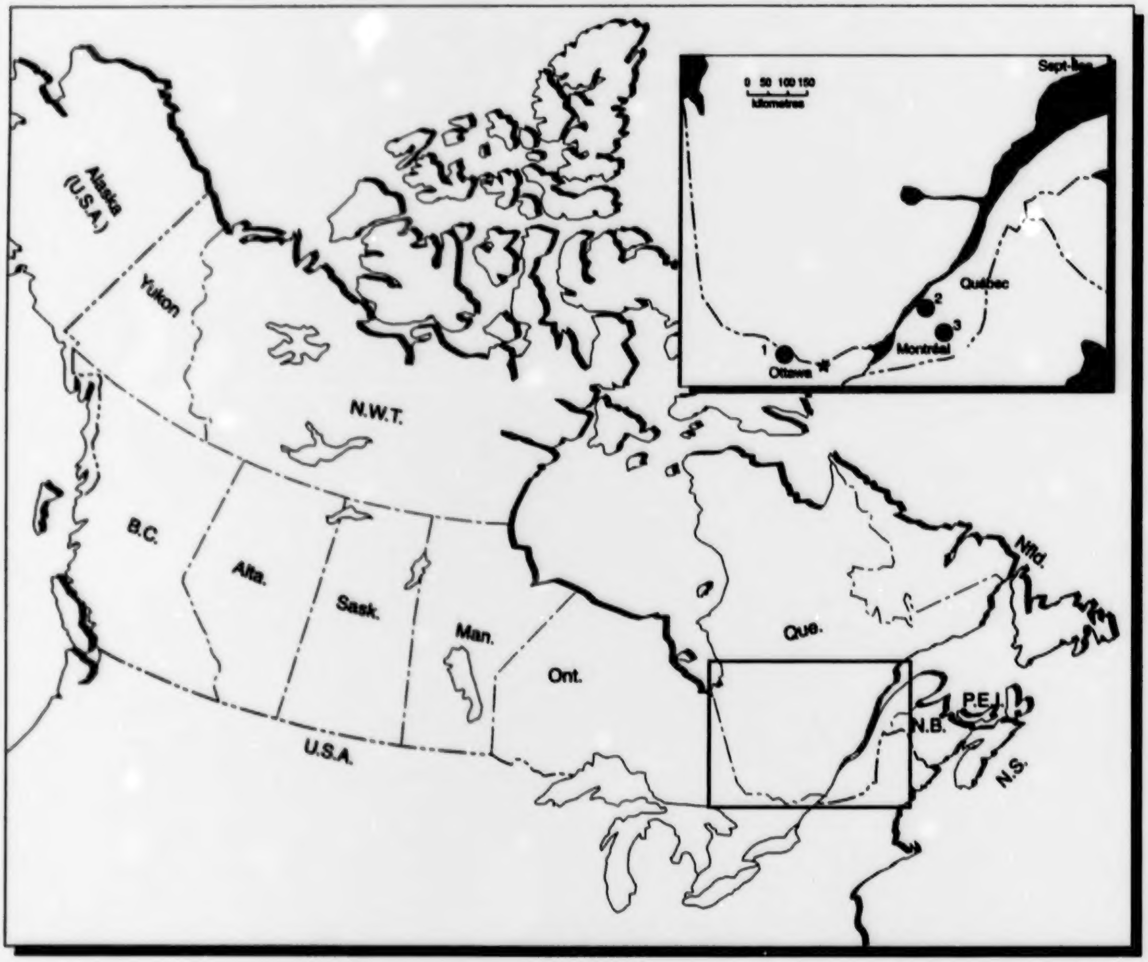
Norsk Hydro Canada Inc., a wholly owned subsidiary of Norsk Hydro ASA of Norway, produces magnesium metal at a 43 000-t/y Bécancour, Quebec, plant using an electrolytic process. The company announced in 1997 that it would increase the plant's capacity in a two-phase expansion project that was scheduled to begin in 1998. The first phase would increase capacity to 68 000 t/y and, once the first stage is operational, a second phase would further increase capacity to 86 000 t/y. Existing dehydration units will be modified to accommodate the first phase. In addition, the project will include new electrolytic capacity and technological improvements that will lead to higher productivity per cell. Other planned changes would reduce energy consumption. The overall improved efficiencies and economies of scale are expected to reduce the plant's operating costs. Norsk is currently testing and qualifying each step of the proposed expansion. Norsk's board will make a final decision on the expansion in mid-1999 and, if approved, additional magnesium production from the expansion would start in 2000, reaching full capacity in 2001. (Further information can be obtained on the Internet at http://www.hydro.com/.)

On June 29, 1998, Norsk Hydro Produksjon a.s., another wholly owned subsidiary of Norsk Hydro ASA, and Teksid S.p.A., a wholly owned subsidiary of Fiat S.p.A. of Italy, made an offer to acquire the remaining 44% of Meridian Technologies Inc. that they did not already own. Subsequently, Meridian became a wholly owned subsidiary of Norsk and Teksid. Meridian is the world's largest magnesium die caster with plants in Strathroy (Ontario), Eaton Rapids (Michigan), and Verres (Italy), with 1997 annual sales of $366 million. (Further information can be obtained on the Internet at http://www.mni.ca/.) Teksid manufactures and sells metallurgical components for the international automotive industry.

Timminco Limited produces high-purity metal (up to 99.98% pure) for specialized market applications at its 6000-t/y magnesium plant at Haley Station, Ontario. The company also produces highly corrosion-resistant magnesium die-casting alloys and extruded anode rods for hot-water heaters. Timminco's magnesium products are used for a variety of applications such as alloying agents for aluminum and calcium, in Grignard reagents for the pharmaceutical industry, and in electronic products. Timminco uses the Pidgeon magnesium process in which calcined dolomite is reduced by ferrosilicon in a vacuum retort. Timminco mines the dolomite at the plant site but purchases the ferrosilicon feed on the open market.

In 1998, Timminco continued to implement a program to address the company's capacity limitations in its plants. The company completed expansion of its Haley extrusion plant, improvements to casting

Figure 1
Magnesium Smelters, 1998



SMELTER	COMPANY	CAPACITY (t/y)
1. Haley Station, Ontario	Timminco Limited	6 000
2. Bécancour, Quebec	Norsk Hydro Canada Inc.	43 000
3. Danville, Quebec (proposed)	Magnola Metallurgy Inc.	63 000

capabilities, and construction of a new granulation facility. Timminco also plans to complete a new magnesium melting and alloying facility in 1999 as the final step in a multi-phased capital expenditure program that began in 1995.

After receiving approvals from Quebec's Environment Minister, Magnola Metallurgy Inc. (held 80% by Noranda Inc. and 20% by Société générale de financement du Québec) started construction on its 63 000-t/y commercial magnesium plant in Danville, Quebec. Magnola Metallurgy Inc. cast its first magnesium ingot at a pilot plant in Salaberry-de-Valleyfield, Quebec, in March 1997. The ingot was the first of its kind, and was produced by an innovative production process that was developed over the last 10 years by researchers at the Noranda Technology Centre. Noranda's proprietary process allows for the production of magnesium metal from the mining residues of

local asbestos mines. The plant is expected to be the world's lowest-cost producer of magnesium.

Construction of Magnola's $733 million plant is proceeding on schedule with approximately 650 workers on the site since April 1998. The plant is expected to produce its first metal in June 2000 with full production in the first quarter of 2001. In addition to the construction work generated by the project, nearly 350 direct permanent jobs will be created by the operation of the plant. (For further information on Magnola, visit its web site at http://www.magnola.com/.)

Over the past year in Canada, as in the rest of the world, there has been an interest in the production of magnesium metal from dolomite or from previously mined asbestos deposits. The Canadian projects include Gossan Resources Ltd. at Inwood, Manitoba; Minroc Mines Inc. at Cassiar, British Columbia; and Canadian Magnesium Corporation at Baie Verte, Newfoundland.

In September 1997, Gossan Resources Ltd. announced the results of a pilot plant study by Hazen Research of Golden, Colorado. The study confirmed that dolomite at the company's Inwood, Manitoba, property (67 Mt grading 21.6% magnesium oxide) can be made into commercial-grade magnesium metal using the Magnetherm process. Gossan is awaiting completion of financing for a marketing study for the magnesium and calcium products from the property. (Further information can be obtained from Gossan's web site at http://www.gossan.ca/.)

Minroc Mines Inc. has announced that a preliminary assessment, carried out by Hatch & Associates, indicates that the tailings from the former Cassiar mine in British Columbia have potential for the production of magnesium. The company is in the process of arranging financing for a feasibility study of the project and plans to carry out such a study on a 30 000-t/y operation in 1999. (Further information can be obtained on Minroc's web site at http://www.minroc.com/.)

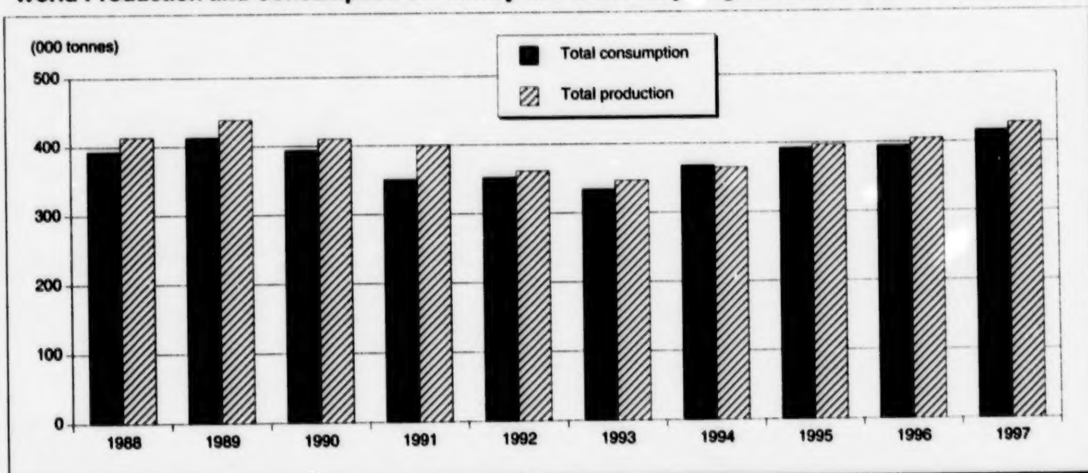
A proposal was submitted to the Government of Newfoundland by Geotech Survey on behalf of Canadian Magnesium Corporation to develop a plant to extract magnesium oxide from the tailings at the former Baie Verte asbestos mine in Newfoundland. The company has received a mineral lease and the project is undergoing feasibility studies for the development of a pilot project for the extraction of magnesium from the tailings.

WORLD DEVELOPMENTS

Western World primary magnesium production was reported by the IMA to have increased to 272 100 t in 1998 from 244 200 t in 1997. This is a new record, surpassing the previous record of 260 800 t set in 1990. Year-end inventories of 44 300 t were 11 400 t higher than at the end of 1997.

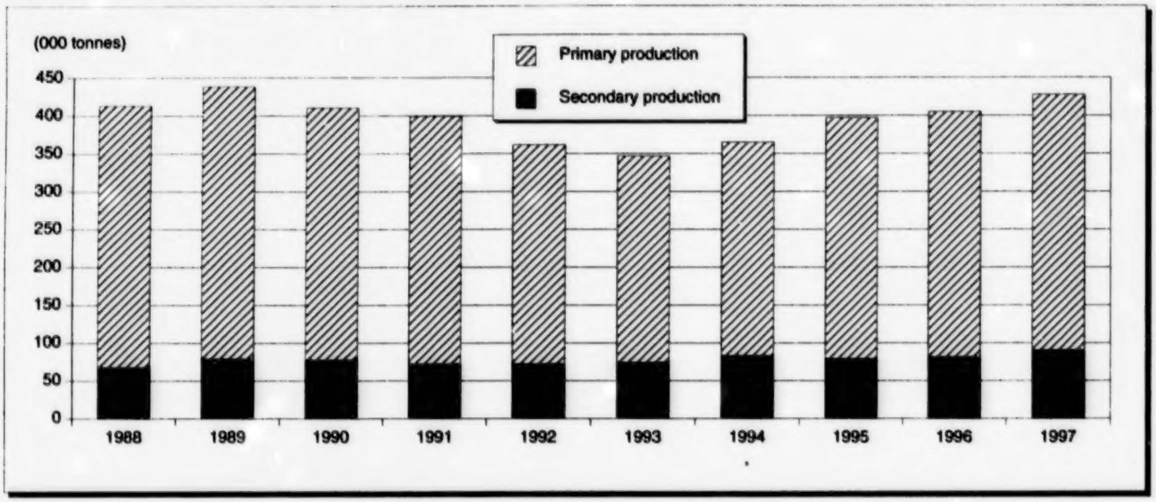
The IMA also reported that shipments in North America remained strong with 210 700 t shipped in 1998, compared to 197 700 t in 1997. This reflected the increased demand in some of magnesium's key market sectors, particularly in Western Europe and North America. (Further information can be obtained on the Internet at http://www.intlmag.org/.)

Figure 2
World Production and Consumption of Primary and Secondary Magnesium, 1988-97



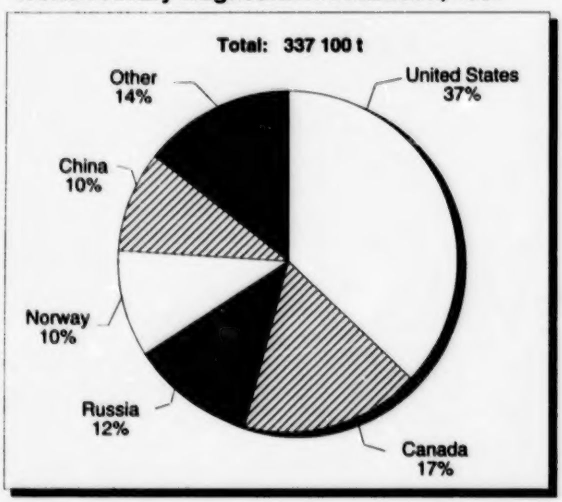
Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics.

Figure 3
World Production of Magnesium, 1988-97



Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics.

Figure 4
World Primary Magnesium Production, 1997



Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics.

United States

At the end of 1998, the United States had two operating primary magnesium smelters. Magnesium Corporation of America (Magcorp) operates a 41 000-t/y electrolytic plant in Rowley, Utah. Magcorp, a wholly owned subsidiary of Renco Metals, Inc., continued an upgrading program that began in 1997. The company has been developing new electrolytic cell technology to improve efficiency and to comply with new environmental standards that will require reductions in chlorine emissions. It will also install a new magnesium caster to improve product quality and produce custom shapes at a lower cost. Prototype work on cell technology is expected to be completed in mid-1999, and the conversion of cells will take an additional two to three years. The caster is expected to be operational in late 1999.

Northwest Alloys, Inc., a subsidiary of Alcoa Inc., operates a 38 000-t/y magnesium plant in Addy, Washington. Northwest Alloy's plant uses the Magnetherm silicothermic process in which magnesium is produced by reducing dolomite with ferrosilicon. The bulk of Northwest Alloy's production is shipped for use by Alcoa subsidiaries.

The Dow Chemical Company, formerly the largest U.S. magnesium metal producer, operated an electrolytic plant at Freeport, Texas. The plant had a production capacity of 65 000 t/y when it was closed in November. Magnesium chloride feedstock for the plant was derived from a seawater-dolomite process. Damages resulting from storms in 1998 (Hurricane Frances, a lightning strike in June, and storms in August and September) resulted in the plant closure. The company declared *force majeure* on September 30, 1998, and, on November 20, 1998, Dow announced that it would stop producing magnesium at its Freeport, Texas operation, which had originally started producing magnesium in January 1941. The company intends to continue producing magnesium chloride and hydrochloric acid at the plant and is

licensing its magnesium technology. (Further information can be obtained on the Internet at http://www.dow.com/pr_business/mag.html.)

In July 1998, Timminco completed arrangements to purchase Dow Chemical Co.'s Fabricated Metals Business in Aurora, Colorado. The unit employs 82 full-time and 43 contract workers and has annual sales of about US$40 million of fabricated extruded products.

Two separate reviews were conducted by the International Trade Administration (ITA) related to the establishment of countervailing duties and of antidumping duties on magnesium imports from Norsk Hydro Canada Inc. In a preliminary review published on May 12, 1998, covering the period August 1, 1996 to July 1997, a preliminary ruling set antidumping duties for pure and alloy magnesium at 0% *ad valorem*. This is the third time a review set antidumping duties at 0%, but the ITA has indicated it will not revoke the antidumping order. The ITA subsequently extended the time limit for the final result to March 8, 1999. In the second review, the ITA issued preliminary results of the fifth countervailing duty review for pure and alloy magnesium for 1996. As a result, for the period covering 1998, the ITA established countervailing duties at 2.78% *ad valorem* for pure and alloy magnesium from Norsk Hydro. The ITA has begun another investigation that is scheduled to be completed in 1999. (Further information can be obtained on the Internet at http://www.usitc.gov/, or at http://www.ita.doc.gov/.)

The Court of International Trade (CIT) upheld a decision that the U.S. magnesium industry is not injured by imports from Ukraine. In 1995, the International Trade Commission (ITC) imposed antidumping duties ranging from 74.87% to 104.27% on pure magnesium from Ukraine. The duties were appealed to the U.S. Court of Appeals in 1995, the case was remanded back to the CIT in 1997, and the upheld decision was a result of the appeal. As a result of the remand order, the ITC is re-opening its anti-dumping investigation. (Further information can be obtained on the Internet at http://www.ita.doc.gov/.)

The U.S. Department of Commerce (DOC) issued final results for a review of the antidumping duty order on sales of pure primary magnesium from China's Taiyuan Heavy Machinery Import and Export Corp. for the period May 1, 1996 to October 31, 1996. The DOC determined that sales were made below the normal value and instructed the U.S. Customs Service to assess antidumping duties based on the difference between export price and the normal value. The duties were set at 69.53%. (Further information can be obtained on the Internet at http://www.usitc.gov/, or at http://www.ita.doc.gov/.)

For additional information on magnesium production in the United States and other general information on magnesium, visit the U.S. Geological Survey's web site at http://minerals.er.usgs.gov.

Europe

The European Commission (EC) investigated imports of unwrought unalloyed magnesium imports from China following a complaint by the European Alloys Association, Euroalliages, on behalf of Pechiney SA for its wholly owned subsidiary Pechiney Électrométallurgie of France. Pechiney Électrométallurgie is the sole producer of magnesium within the European Union. The investigation, started last year, found that China had dumped magnesium, which harmed the EU-based industry and caused material injury to the European industry. As a result, European Community Council Regulation 2402/98, dated November 8, 1998, imposed an antidumping duty on imports of unwrought unalloyed magnesium originating from China.

The ruling lowered the minimum price to 2622 European Currency Units (ECU) per tonne for unwrought unalloyed magnesium from a provisional price of 2797 ECU/t established in May 1998. The final ruling includes a table of all the commonly used alloys and, if an import does not fit the table, it will be subject to duty. Alloyed magnesium was defined as magnesium containing more than 3% of intentionally added alloying elements. The duty will be the difference between the minimum import price of 2622 ECU/t and any lower c.i.f. community frontier price. All other cases are subject to an *ad valorem* duty of 31.7%. (Additional information is available on the Internet at http://europa.eu.int.)

Icelandic Magnesium Co. conducted work on engineering and environmental studies on a proposed 50 000-t/y smelter in Iceland. The company delayed a decision, originally expected in 1998, to build the smelter to enable it to find a major shareholder and conduct further studies. During the year, Australian Magnesium Corporation (AMC) purchased 40% of the company. AMC, a wholly owned subsidiary of Australian Magnesium Investments Pty Ltd., is conducting pilot plant testing of a process that could be used for commercial production of metal. (Refer to the section on Australia below.)

The Antheus Magnesium Project Group has proposed a new magnesium plant in the Eemsmond region in Delfzijl metal park, in the northeastern Netherlands, adjacent to Hoogovens Groep BV's aluminum smelter. The Group includes Nedmag Industries Mining & Manufacturing, a producer of dead-burned magnesia; Hoogovens, which operates an aluminum smelter in Delfzijl; Northern Netherlands Development & Investment Co.; and the Netherlands' Ministry of Economic Affairs. The proposed magnesium plant would have a capacity of 40 000-60 000 t/y, and

the Group hopes that it will be operational in 2005. Feasibility studies are expected to be completed in 1999.

Russia

Solikamsk Magnesium Works is continuing work on feasibility studies for a 25 000-t/y expansion to bring its capacity to 42 000 t/y. An investment plan was approved by the European Bank for Reconstruction and Development, but it was revised as Solikamsk coped with problems of falling prices and the unstable Russian financial climate. The plan has been studied by Daimler Benz, which pledged part of the financing for the expansion in return for magnesium supplies.

Russia's only other primary magnesium producer, Avisma Titanium-Magnesium Works, reported that the plant was operating at below its full capacity of 18 000 t/y. Production in 1998 from the plant, which is expected to be around 16 000 t, is shipped primarily to export markets in the European Union and the United States.

Kazakstan

Ust-Kamenogorsk Titanium-Magnesium Works, which closed in 1994, resumed magnesium production in 1998 and was reported to have produced 6000 t. The company is expected to reduce its magnesium production from this level in 1999.

Israel

Dead Sea Magnesium Ltd. (DSM) is a joint venture of Dead Sea Works Ltd. (DSW) of Israel (65%) and Volkswagen AG of Germany (35%). DSM completed its second full year of operation at its plant at Sdom, Israel. It experienced some difficulty in bringing the plant on line and with financing, but production has now stabilized and the company has sold magnesium production beyond its commitments to Volkswagen. DSM has changed from a batch process to a continuous flow process and has removed bottlenecks in the operation. The plant is running at approximately a 25 000-t/y level, and the company has been considering construction of a die-casting plant in Dimonea, 40 km from the smelter.

Potash Corporation of Saskatchewan (PCS Inc.) purchased 9% of Israel Chemicals Ltd. in a public offering in December 1998. Early in 1999, PCS Inc. confirmed that it was negotiating to acquire an additional interest in Israel Corp., which owns 52% of Israel Chemicals Ltd., the parent company of DSW. (Additional information can be obtained on the Internet at http://www.dsw.co.il/, or at http://www.potashcorp.com/.)

China

China's magnesium metal production capacity, in approximately 500 plants, is estimated at approximately 200 000 t/y. Its actual production is about half of that capacity due to the closure of small plants because of low prices in 1998. About 50 plants were reported to be in production at the end of 1998.

The China National Nonferrous Metals Industry Corporation's (CNNC) participation in the magnesium industry has been replaced by a new group, the State Bureau of Nonferrous Metals Industry Administration. It is reported that, unlike the CNNC, the Administration's duties are to make plans on a whole industry basis based on economic returns, and plants will be controlled at the operational level. The Administration is also reported to have instructed all operations to reduce stocks and to expand exports.

As a result of the rapid development of China's primary magnesium industry in 1994 and 1995, and the limited demand in the domestic market, China has become a major exporter of primary magnesium to the Western World in recent years. Exports of primary magnesium totalled more than 77 000 t in 1997, or approximately one quarter of world primary shipments. Since the United States imposed anti-dumping duties on China's unwrought magnesium, China's primary magnesium exports have been mainly focused on the European and Japanese markets.

As a result of duties imposed on Chinese magnesium by the United States, Europe and India, the Chinese National Magnesium Industry Association attempted to establish a floor price for exports. Late in 1998, China's new National Magnesium Products Export Coordination Committee, representing 36 producers, set minimum export prices for magnesium at US$1950/t for October to December 1998, and set US$2320/t as the minimum price for 1999.

The Wenxi Yinguang Magnesium Industry group has purchased a number of magnesium-producing plants in Shanxi Province and plans to acquire more. The company expects to produce 14 000 t in 1999.

Milky Way Magnesium in Hebei Province ceased production of magnesium in 1998 due to low prices, but the equipment will remain and could be restarted if prices increase. The company will continue to produce magnesium granules, powder and filings.

Republic of the Congo (Brazzaville)

Magnesium Alloy Corp. continued work on its Kouilou project in the Republic of the Congo (Brazzaville) during 1998. The company has two 2400-km^2 exploration permits located in the Kouilou region. Previous exploration work for potash and oil

indicate the presence of potassium and magnesium salts, including carnallite, sylvanite and bischofite. A drill hole, completed in 1998, confirmed presence of the magnesium-bearing salt beds.

The company has negotiated a contract with the Congolese government to evaluate and, if feasible, finance to production a magnesium solution mining and extraction plant. Consulting and technology transfer agreements with Salzgitter Anlagenbau, the Russian National Aluminum and Magnesium Institute and SNC-Lavalin have focused on producing an advanced prefeasibility study to evaluate a proposed 60 000-t/y plant in Pointe-Noire to produce magnesium metal. Work on prefeasibility studies is scheduled for completion early in 1999 and, if results are positive, will be followed by a feasibility study. The company indicates that if current and subsequent work and studies are successful, magnesium production could potentially start in late 2002. (Additional information can be obtained on the Internet at http://www.magnesiumalloy.ca/.)

Australia

Australian Magnesium Corporation (AMC), based in Brisbane, completed construction of a 1500-t/y magnesium and metal alloy demonstration project as part of feasibility work towards a 90 000-t/y commercial metal plant. AMC is a wholly owned subsidiary of Australian Magnesium Investments Pty Ltd., which in turn is owned equally by Queensland Metals Corporation Limited and Normandy Mining. Work on the pilot project began in early 1997 after a company announcement that Ford Motor Company had committed to invest US$30 million in the project in return for an agreement to purchase magnesium metal. Fluor Daniel is earning a 5% equity in AMC through the provision of engineering services. The magnesium will be produced from magnesite from Queensland Metals Corporation's Kunwara magnesite project using a process developed by the Commonwealth Scientific and Industrial Research Organization (CSIRO). CSIRO has worked with Queensland Metals for more than 10 years to develop a low-cost process to produce magnesium metal from magnesite. CSIRO has agreed to provide expertise to the demonstration project and contribute A$7 million to the project, which was estimated to cost A$110 million. As a non-equity partner, it will receive a royalty from the company.

AMC indicates that if the technology is viable, construction of a commercial plant with an estimated cost of A$700 million could begin in mid-1999, with production of metal starting in 2002 and achievement of full production in 2004. The company assessed four sites for the smelter's location and has chosen a site at Stanwell, approximately 50 km south of the Kunwara deposit. The pilot plant had produced anhydrous magnesium oxide by year-end and metal production was expected in early 1999. A decision on construction of the smelter is expected in late 1999. The company is also studying a second plant in Iceland with its purchase of an interest in Icelandic Magnesium. (Additional information is available on the Internet at http://www.normandy.com.au/.)

A number of companies in Australia have shown an interest in developing resources of magnesite or magnesium-rich mineral residues to produce magnesium metal. Australian projects include: Crest Magnesium NL's property in Tasmania, Golden Triangle Resources NL's project in Tasmania, Mt. Grace Resources' project in the Northern Territory, and Samag Ltd.'s project in South Australia.

Crest Magnesium signed an agreement with Multiplex Construction Proprietary to fund drilling and a bankable feasibility study of its magnesite property in the Arthur and Lyons rivers area in northwestern Tasmania, and for financing and building a 95 000-t/y magnesium metal plant, likely near Bell Bay. A prefeasibility study was completed in mid-October by BHP Engineering Pty and Hatch Associates of Canada. The study indicated that a project could be commercially viable with operating costs of US$0.65/lb using the company's rights to technology from the Ukrainian National Research & Design Titanium Institute and the Aluminium & Magnesium Institute (VAMI) in Russia. The company has been considering doubling the size of the proposed plant and expects to complete a feasibility study in 1999. Construction could potentially start in 2000 with completion scheduled for 2002.

Golden Triangle Resources NL is spending A$750 000 to outline reserves of magnesite ore at its Main Creek mine in Tasmania. The company is also looking at asbestos tailings at its Woodsreef project in New South Wales. Golden Triangle has appointed Lakefield Research to begin the second phase of laboratory work towards a pilot plant program. A feasibility study is expected to be completed in 1999. (Further information can be obtained from Golden Triangle's web site at http://www.goldentriangle.com.au/.)

Samag Ltd. (owned 80% by Pima Mining Nl) is discussing joint ventures based on magnesite deposits near Leigh Creek in the Willouran Ranges region of South Australia. The company has committed to spending A$1.5 million on a feasibility study, completion of a resource outline and metallurgical testing for a proposed 52 000-t/y smelter at Port Augusta in South Australia. The study is expected to be completed in 1999.

Mt. Grace Resources has started work on a prefeasibility study for a project at its Northern Territory Batchelor magnesium project. Drilling was reported in 1998 on the deposit, which is located 85 km south of Darwin in the Northern Territory.

CONSUMPTION AND USES

Total world consumption of primary magnesium reached 323 600 t in 1997, compared to a revised total of 302 000 t in 1996. In Canada, reported magnesium consumption in 1997 increased by 6450 t to 34 026 t. The consumption of magnesium metal for castings and wrought products increased by almost 5600 t to 16 795 t. There was also a 3% increase in reported demand for magnesium in the production of aluminum alloys to a record 14 793 t.

Magnesium is the eighth most abundant element, comprising over 2% of the earth's crust. It is the third most abundant element dissolved in seawater with a concentration averaging 0.14% by weight. Magnesium does not naturally occur in its native or metallic state, but is found in over 60 different minerals. The principal magnesium minerals include carbonate forms in dolomite and magnesite; as a silicate in olivine and brucite; as an oxide in serpentine; and as a chloride in seawater, natural brines and evaporites. Magnesium metal is produced from three major sources: dolomite/magnesite, seawater, and brines.

Magnesium metal is best known for its light weight and high strength-to-weight ratio, making it suitable for a wide range of applications. When used as a structural material, magnesium is alloyed with other elements including aluminum, manganese, rare-earth metals, silver, thorium, zinc and zirconium. When alloyed with one or more of these elements, the resulting alloys can have unusually high strength-to-weight ratios. Magnesium-aluminum alloys are the most common and are principally used in die-casting applications.

The main application of magnesium is as an alloying agent for aluminum, accounting for 43% of Western World consumption of primary magnesium in 1998. According to the IMA, Western World magnesium shipments for this application reached 154 400 t in 1998, up 6% compared to the 146 150 t shipped in 1997. Magnesium consumption for this application is forecast to increase by 2% annually.

The second largest use of magnesium is in structural applications where high-pressure die-cast products are the most important use. The IMA reported that shipments of primary magnesium in 1998 for die-cast applications increased by 16% to a total of 110 100 t from 95 300 t in 1997. During the next decade, high-pressure die casting is expected to be the fastest growing sector, particularly in the United States and Europe.

The increased interest in magnesium metal in the automotive market is largely due to weight savings of about 33% compared to aluminum. Magnesium also has good vibration-dampening characteristics. Its lower heat of solidification, which increases die-casting production capacity by 25%, results in major process energy savings. In addition, magnesium dies are reported to have more than twice the life of aluminum dies. Furthermore, at a magnesium-to-aluminum price ratio of 1.7:1.0 or less, many magnesium metal parts can be fabricated at a lower cost than those made from aluminum.

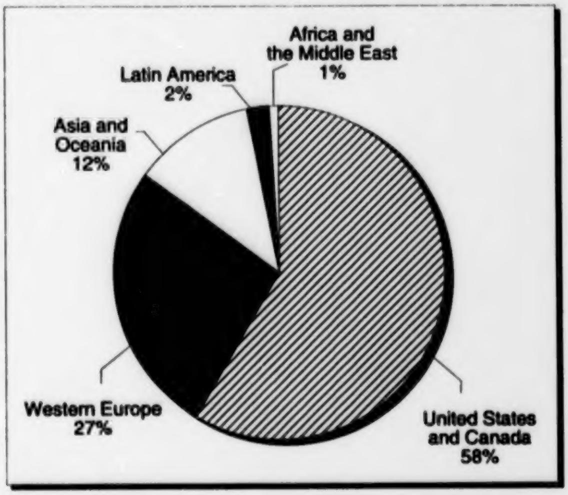
The enforcement of stricter fuel efficiency and emissions standards is encouraging many auto manufacturers to reduce their vehicles' weight. Increased consumer demand for cars with added luxury items is also driving manufacturers to find ways to reduce automobile curb weight. Many automobile manufacturers in both the United States and Japan are looking to magnesium to help reduce total vehicle weight without sacrificing consumer demand for larger vehicles.

In addition to automotive applications, die-cast magnesium products are widely used in the manufacture of portable tools and sporting goods. The use of magnesium in electronics equipment, particularly computer housings and components, has grown substantially. This trend is expected to continue. Magnesium's advantages for these applications are its good strength-to-weight ratio, heat dissipation, electromagnetic field containment, and radio frequency interference dissipation.

The third largest use of magnesium is as a desulphurizing agent in the ferrous industry. Magnesium shipments in 1998 for desulphurization, as reported by the IMA, totalled 48 200 t in 1998, an increase of about 1% from the 47 950 t shipped in 1997. This sector, which grew at an average rate of 15%/y in the late 1980s, should see a more moderate growth rate because of the rationalization that took place in the steel industry.

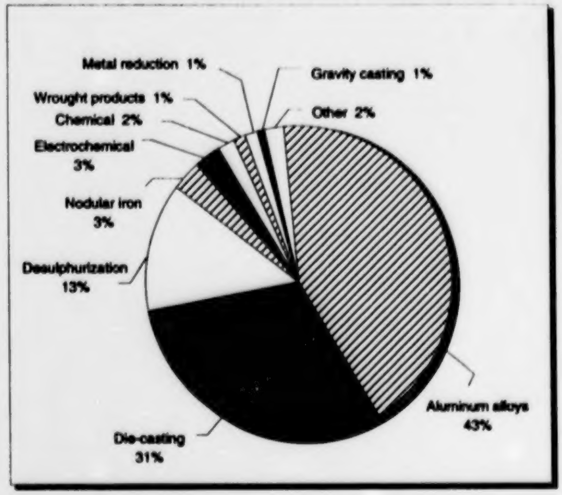
Magnesium is introduced into the melt during the production of nodular iron, which is used primarily for the production of ductile iron pipes and die-cast parts for use in automobiles and farm equipment. Shipments in 1998 totalled 11 300 t, down from 11 750 t in 1997. This application is expected to continue to face stiff competition as plastics increasingly penetrate the water pipe market. Magnesium is also used as a reducing agent in the production of titanium, beryllium, zirconium, hafnium and uranium. Electrochemical applications account for about 4% of magnesium consumption for use in the manufacture of batteries and in anodes for the cathodic protection of gas pipelines and water heaters. As with nodular iron, plastics in the gas pipeline market continue to penetrate this market. Chemical applications include the manufacture of pharmaceutical products, perfumes and pyrotechnics. Wrought products mainly include extruded products, except anodes, sheets and plates; gravity casting includes the production of complex or large parts by sand casting or casting with other materials.

Figure 5
Magnesium Shipments by World Zone, 1998[e]



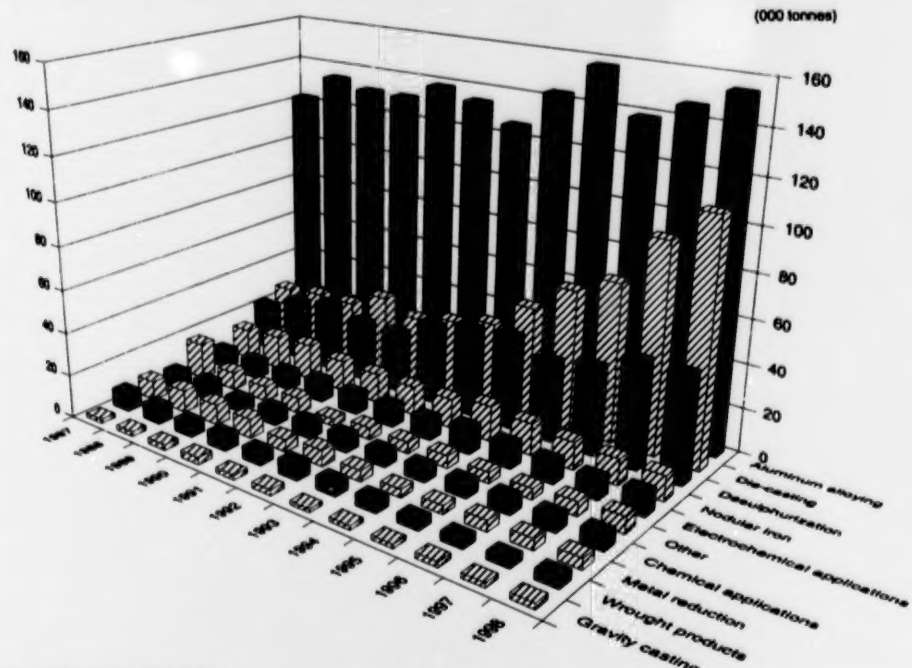
Source: International Magnesium Association.

Figure 6
Magnesium Shipments by Use, 1998



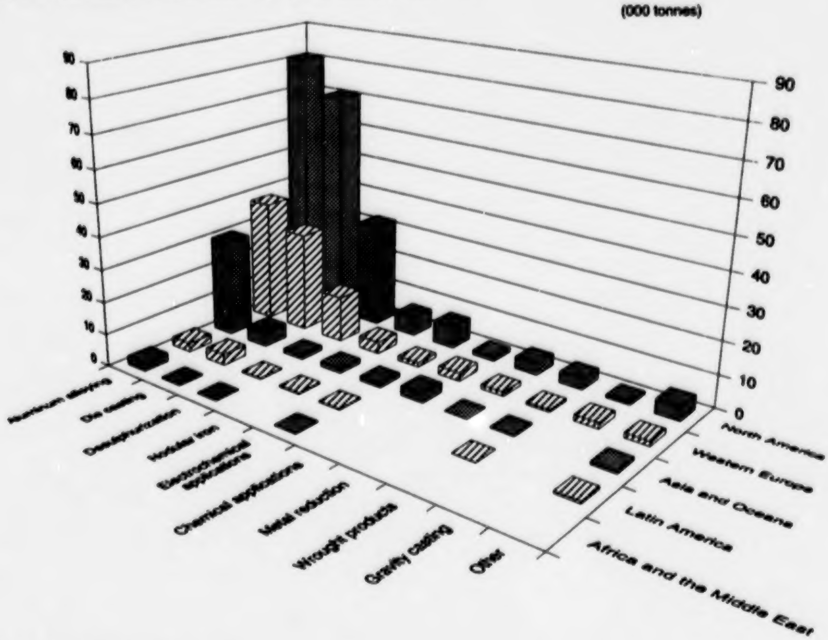
Source: International Magnesium Association.

Figure 7
Primary Magnesium Shipments by Category, 1987-98



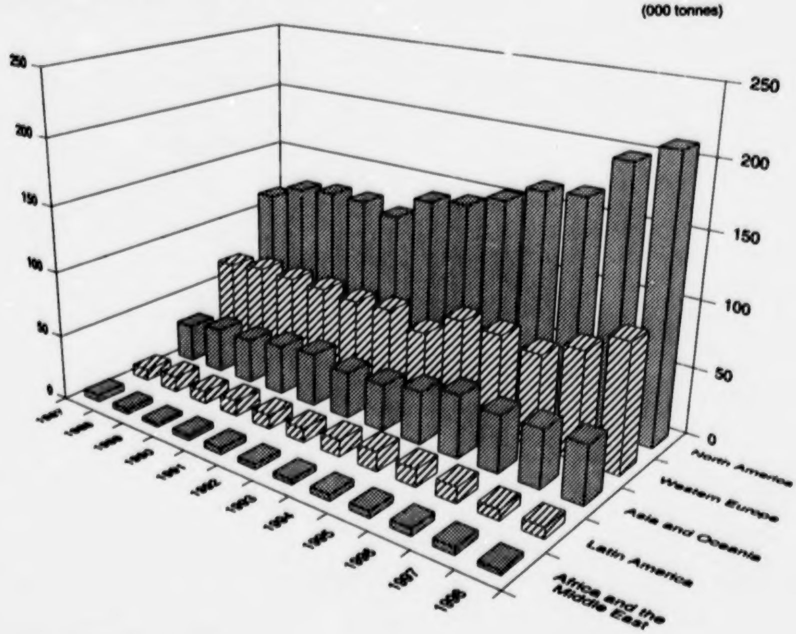
Source: International Magnesium Association.

Figure 8
Primary Magnesium Shipments by Type and Area, 1998



Source: International Magnesium Association.

Figure 9
Primary Magnesium Shipments by Area, 1987-98



Source: International Magnesium Association.

RECYCLING

The anticipated growth for magnesium die-cast parts in the automotive sector should provide greater opportunities for magnesium recycling. Norsk Hydro Canada and Dow Chemical collect magnesium scrap from their clients. This source of supply is expected to increase as magnesium metal further penetrates the automotive market.

Similar to aluminum, recycled magnesium only requires about 5% of the energy required to produce primary magnesium. The recycling of magnesium is expected to increase with the anticipated growth in the use of magnesium die-cast automobile parts.

In 1998, Chrysler approved the use of 100% recycled magnesium for die-cast components from parts suppliers. Both Ford Motor Company and General Motors have used parts made from recycled magnesium for several years. The use of recycled magnesium reduces the cost of die-cast components.

PRICES AND STOCKS

As a relatively new metal, the quantity of magnesium produced and used is less than many other metals used for industrial and structural purposes. As a result, markets for the metal are young and not well developed. Magnesium is not traded on the London Metal Exchange nor on the New York Mercantile Exchange (NYMEX) on a daily basis. In addition, due to the limited market, magnesium prices are sensitive to supply and demand in the end use markets. Many producers have direct sales contracts with large consumers, often on a long-term basis. Magnesium producers' list prices can be taken as a general guide, but prices are dependent on many factors, including the quality, purity, location, shape and amount desired by an end user.

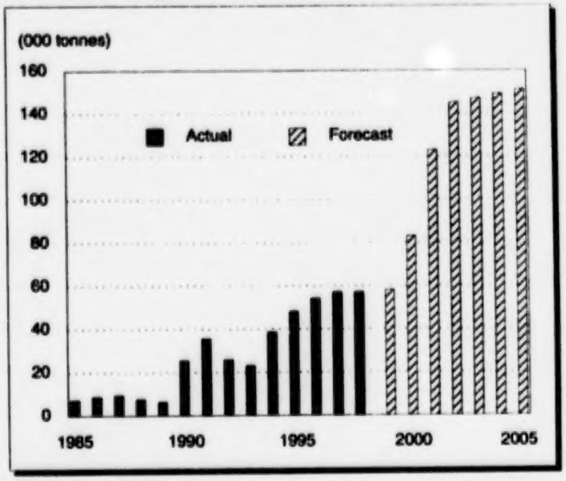
In general, prices for magnesium weakened throughout the year. *Metals Week* reported that the U.S. Spot Western mean price started the year at US$1.60/lb, increased to US$1.63/lb in February, but then started decreasing in May to reach US$1.57/lb by year-end, averaging US$1.59/lb for the year compared to US$1.66/lb for 1997. Similarly, the U.S. Dealer Import mean price started the year at US$1.52/lb and decreased to US$1.31/lb by year-end, for an average of US$1.38/lb for the year compared to the 1997 average of US$1.44/lb.

According to the IMA, total magnesium stocks increased steadily throughout the year from 33 800 t at the end of 1997 to 44 300 t by the end of 1998. This represents approximately 39 days of world consumption.

OUTLOOK

Canadian production of magnesium increased dramatically at the start of the decade with the opening of Norsk Hydro's 40 000-t/y Bécancour smelter in 1989. Canada's installed capacity has since remained stable, but it is set to rise again with the proposed expansion of Norsk Hydro's Bécancour plant and the addition of Magnola Metallurgy's 63 000-t/y plant at Danville, Quebec. Once completed, Canadian primary magnesium production capacity will rise to about 150 000 t/y. Canada was the second largest producer of primary magnesium in the world in 1997 after the United States. World primary magnesium production is expected to rise from 337 100 t in 1997 to 360 000 t/y by 2000 and to 500 000 t/y by 2005.

Figure 10
Canadian Magnesium Production, 1985-2005



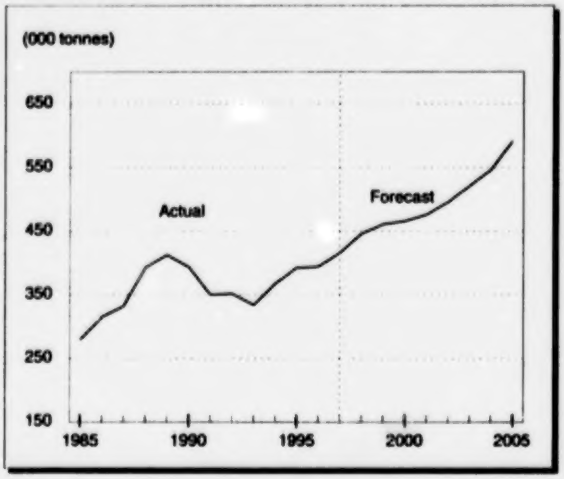
Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics.

World primary magnesium consumption was 323 600 t in 1997, and is expected to increase to 375 000 t/y by 2000 and to 495 000 t/y by 2005. The Western World's primary magnesium annual growth in demand for this period is expected to reach 5% in North America, 4% in Western Europe, and 9% in the Far East. This growth will be fed primarily by a strong demand for magnesium in aluminum alloys, die-cast automotive parts and desulphurization applications in the steel industry. Magnesium continues to face stiff competition from other materials, including aluminum and plastics, in the all-important automotive parts sector. New applications and increased awareness of the advantages of magnesium in certain applications are, however, growing, particularly in the North American automotive industry.

Continued strength in prices is forecast in the short term, with North American primary ingot prices expected to remain in the US$1.70-$1.90/lb range for 1999. A major factor that will influence magnesium prices in the longer term will be the change in supply over the next decade as the result of expansions or the opening of new capacity in Canada, the Congo, Iceland, the Middle East, Australia, and possibly China. The availability of this newer, low-cost supply without a concurrent corresponding increase in consumption may eventually cause prices to decline, in constant dollar terms, over the next decade. Over the longer term, prices are expected to remain in the US$1.60-$1.70/lb range in constant 1998 dollars.

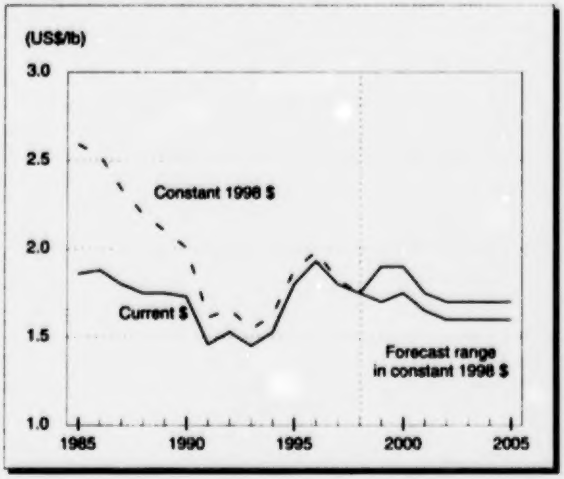
Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of February 20, 1999.

Figure 11
World Primary Magnesium Consumption, 1985-2005



Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics.

Figure 12
Magnesium Prices, 1985-2005



Source: Natural Resources Canada.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EU MFN	Japan[1] WTO
8104.11	Magnesium unwrought, containing by weight at least 99.8% of magnesium	2.5%	Free	Free	Free	5.3%	1.3-3.7%
8104.19	Magnesium unwrought, other						
8104.19.10	Magnesium-rare earth, magnesium-didymium, magnesium-thorium, magnesium-zirconium and magnesium-thorium-neodymium-rare earth for use in the manufacture of magnesium castings	Free	Free	Free	Free	4.3%	1.3-3.7%
8104.19.90	Other	2.5%	Free	Free	Free	4.3%	1.3-3.7%
8104.20	Magnesium waste and scrap	Free	Free	Free	Free	Free	2.3%
8104.30	Magnesium raspings, turnings and granules, graded according to size; powders	2.5%	Free	Free	Free	4.3%	3.8%
8104.90	Other magnesium	2.5%	Free	Free	Free	4.3%	3.8%

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999; Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of the European Union (38th Annual Edition: 1998); Custom Tariff Schedules of Japan, 1998.
[1] WTO rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADA, MAGNESIUM EXPORTS AND IMPORTS BY COMMODITY AND COUNTRY, 1997 AND 1998

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS					
8104.11	Magnesium unwrought, containing by weight at least 99.8% magnesium				
	United States	1 213	6 882	2 324	12 392
	Germany	2 418	10 191	2 651	11 026
	Japan	1 438	7 143	2 277	10 876
	Australia	1 586	6 655	1 482	6 111
	United Kingdom	744	4 160	382	2 708
	Norway	311	1 293	544	2 095
	Netherlands	160	728	348	1 490
	France	483	2 206	264	1 193
	Other countries	1 053	5 442	483	2 239
	Total	9 406	44 700	10 755	50 130
8104.19	Magnesium unwrought, other				
	United States	26 471	123 950	29 789	150 494
	Australia	530	3 476	573	4 352
	Netherlands	304	2 734	371	2 689
	Italy	340	2 289	352	2 433
	South Africa	59	456	113	1 126
	Germany	92	543	167	1 033
	Other countries	260	1 597	286	1 270
	Total	28 056	135 045	31 651	163 397
8104.20	Magnesium waste and scrap				
	United States	2 226	6 270	2 689	6 960
	Norway	1 128	4 392	–	–
	Other countries	33	81	–	–
	Total	3 387	10 743	2 689	6 960
8104.30	Magnesium raspings, turnings or granules, graded according to size and powders				
	United States	5 051	23 738	4 551	21 509
	Ireland	270	1 985	135	1 054
	Netherlands	111	768	96	758
	Other countries	367	2 163	123	703
	Total	5 799	28 654	4 905	24 024
8104.90	Magnesium and articles thereof, other				
	United States	319	2 527	80	549
	Italy	–	–	12	418
	Other countries	26	188	15	127
	Total	345	2 715	107	1 094
	Total exports	46 993	221 857	50 107	245 605
IMPORTS					
8104.11	Magnesium unwrought, containing by weight at least 99.8% magnesium				
	China	4 188	16 468	3 679	13 690
	Russia	375	1 399	749	3 151
	United States	2 644	13 964	525	2 316
	Other countries	391	1 377	387	1 727
	Total	7 598	33 208	5 340	20 884
8104.19	Magnesium unwrought, other				
	United States	2 408	10 892	4 840	22 798
	Russia	4 784	22 992	4 028	18 258
	China	1 182	4 298	3 092	11 213
	France	–	–	268	1 614
	Other countries	5 846	27 847	302	2 391
	Total	14 220	66 029	12 530	56 274
8104.20	Magnesium waste and scrap				
	United States	11 287	34 246	13 372	43 205
	Other countries	43	208	209	302
	Total	11 330	34 454	13 581	43 507
8104.30	Magnesium raspings, turnings or granules, graded according to size and powders				
	United States	835	3 181	278	1 159
	United Kingdom	20	73	108	469
	Other countries	355	1 285	52	204
	Total	1 210	4 539	438	1 832
8104.90	Magnesium and articles thereof, other				
	United States	430	3 184	223	3 181
	Mexico	44	357	194	1 358
	Other countries	142	648	5	54
	Total	616	4 189	422	4 573
	Total imports	34 974	142 419	32 311	127 070

Source: Statistics Canada.
– Nil; p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, CONSUMPTION[1] OF MAGNESIUM, 1991-97

	1991■	1992■	1993■	1994	1995■	1996■	1997p
				(tonnes)			
Castings and wrought products[2]	4 604	6 915	7 678	8 940	12 488	11 197	16 795
Aluminum alloys	9 215	9 203	10 174	12 389	12 323	14 022	14 793
Other uses[3]	1 926	2 005	2 162	2 234	2 329	2 357	2 438
Total	15 745	18 123	20 014	23 563	27 140	27 576	34 026

Source: Natural Resources Canada.
p Preliminary.
■ Increase in number of companies being surveyed.
[1] Available data as reported by consumers. [2] Die, permanent mould and sand castings, structural shapes, tubings, forgings, sheet and plate. [3] Cathodic protection, reducing agents, deoxidizers and other alloys.

TABLE 3. WORLD PRODUCTION OF MAGNESIUM, 1994-97

Country	1994	1995	1996	1997p
			(tonnes)	
PRIMARY PRODUCTION				
France	12.3	14.5	14.0	14.0
Norway	27.6	28.0	37.8	34.2
Russia	35.4	37.5	35.0	39.5
Serbia & Montenegro	–	2.6	3.1r	3.7
Ukraine	12.0	13.0	13.0	12.0
China	11.0	12.6	14.4	32.2
India	1.0	1.0	1.0	1.0
Japan	3.4	–	–	–
Kazakstan	3.0r	9.0r	9.0r	9.0
Brazil	8.8	9.7	9.0	9.0
Canada	38.6	48.1	54.1r	57.7
United States	128.5	142.1	133.1	124.8
Total primary	281.6	318.1	323.5	337.1
SECONDARY PRODUCTION				
Austria	0.1	0.1	–	–
United Kingdom	0.5	0.5	0.5	0.5
Japan	19.0	11.8	8.4	8.0
Brazil	1.6	1.6	1.6	1.6
United States	62.1	65.1	70.9	80.2
Total secondary	83.3	79.1	81.4	90.3
Total production	364.9r	397.2r	404.9r	427.4

Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics.
– Nil; p Preliminary; r Revised.

TABLE 4. WORLD CONSUMPTION OF MAGNESIUM, 1994-97

Country	1994	1995	1996	1997
		(tonnes)		
PRIMARY PRODUCTION				
Argentina	0.4	0.4	0.4	0.4
Australia•	4.0	4.0	4.0	4.0
Austria	3.5	3.5	1.6[r]	2.2
Belgium/Luxembourg	4.4	4.0	1.3	5.1
Brazil	10.5	10.0	10.0	10.0
Cameroon	0.1	0.1	0.1	0.1
Canada	23.6	27.1	27.6	34.0
China	10.0[r]	22.0	22.0	22.0
Czech Republic	0.4[r]	0.3[r]	0.3	0.3
Denmark	0.2	0.2	0.2	0.2
Egypt•	1.0	1.2[r]	1.0	1.0
Ex-Yugoslavia	0.4	0.2	0.2	0.2
France	16.1	17.0	18.7[r]	20.1
Germany	19.0	19.9	19.6	21.9
Ghana	0.1	0.1	0.1	0.1
Greece	0.1[r]	0.1[r]	0.1[r]	0.1
Hungary	0.2	0.2	0.2	0.2
India	1.8	1.8	1.8	1.8
Italy	4.7	5.4	6.2	9.3
Japan	24.5[r]	27.8[r]	30.9[r]	30.9
Mexico	1.0	1.0	1.0	1.0
Netherlands	1.0	1.2[r]	1.2[r]	1.2
New Zealand•	0.4	0.4	0.4	0.4
Norway•	6.0	6.0	6.0	6.0
Poland	0.5	0.5	0.5	0.5
Romania	0.4	0.3	0.3	2.3
Russia	25.0	25.0	25.0	25.0
South Africa	0.8	0.8	0.7	0.7
South Korea	2.2	2.0	3.1[r]	3.6
Spain	1.7	1.5	1.5	2.3
Sweden	2.2	2.2	1.7	1.6
Switzerland	2.6	2.1	2.4[r]	3.3
Taiwan	1.5	3.0	1.7	2.9
Turkey	0.6	1.5[r]	0.5	0.5
United States	112.0[r]	109.0	102.0	101.0
United Kingdom	6.0	6.0	5.2[r]	4.9
Venezuela	0.6	0.5	0.5	0.5
Other	1.9	2.0	2.0	2.0
Total primary	291.4	310.3	302.0	323.6
SECONDARY MAGNESIUM				
Japan	14.3	17.1	21.6	21.6
United States	62.1	65.0	70.9	70.9
Total secondary	76.4	82.1	92.5	92.5
Total world	367.8[r]	392.4[r]	394.5[r]	416.1

Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics.
• Estimated; [r] Revised.

TABLE 5. WORLD PRIMARY MAGNESIUM SMELTER CAPACITY, 1998

Country	Smelter Location	Company/Plant	Capacity
			(t/y)
Brazil	Bocaiuva	Rima Industrial S.A.	12 000
Canada	Bécancour	Norsk Hydro Canada Inc.	43 000
	Haley Station	Timminco Metals	6 000
China	Baotou	Baotou 202 Factory	3 500
	Dancheng	Dancheng Ferroalloy Factory	1 000
	Fushun	Fushun Aluminium Smelter (CNNC)	5 400
	Guigang	Guangxi Magnesium Smelter	3 000
	Hebei	Fuda Magnesium Plant	3 500
	Henan	Huaqi Magnesium Industry Co.	6 000
	Hengyang	Hunan Magnesium Smelter	3 400
	Huinong	Huinong Xian Smelter	1 400
	Jinzhou	Xinmei Co. Ltd.	3 000
	Liaoning	Chaoyang Rich Magnesium Co.	4 000
	Minhe Xian	Minhe Magnesium Smelter (CNNC)	5 000
	Nanjing Shi	Nanjing Ube Magnesium Co. (CNNC)	14 000
	Ningxia Hui	Silver River Corporation	1 000
	Ningxia	Shizoushan Ferroalloy Plant	4 000
	Shanxi	Min Xian Magnesium Plant	3 000
	Shanxi	Wen Xi Yin Guang Magnesium Industry Group	9 600
	Shanxi	Yinguang Magnesium Group Co.	3 000
	Taiyuan	Taiyuan East United Smelt Magnesium Co. Ltd.	10 000
	Taiyuan	Zhaojiabao Group Co.	4 000
	Tongxin Xian	Tongxin Xian Magnesium Factory	1 700
	Yinchuan Shi	Yinchuan Smelter	1 000
		Guanghua Chemical Industry Co.	3 500
		Linjiang Magnesium Industry Group	7 000
		Yubu Magnesium Industry Co.	4 000
France	Maringnac	Pechiney	18 000
India	Hyderabad	Southern Magnesium and Chemicals	1 000
Israel	Sdom	Dead Sea Magnesium Ltd.	25 000
Kazakstan	Ust Kamenogorsk	Ust Kamenogorsk Works	40 000
Norway	Porsgrunn	Norsk Hydro ASA	55 000
Russia	Solikamsk	Solikamsk Works	20 000
	Berezniki	Avisma Titanium-Magnesium Works	25 000
Ukraine	Kaluzh	Kaluzh Works	24 000
	Zaporozhyre	Zaporozhyre Works	45 000
United States	Freeport	The Dow Chemical Company[1]	65 000
	Addy	Northwest Alloys Inc.	38 000
	Rowley	Magnesium Corp. of America	41 000
Former Yugoslavia	Bela Stena	Magnohrom	9 000
Total			572 000

Source: Natural Resources Canada.
CNNC China National Nonferrous Metals Industry Corporation (now the State Nonferrous Metals Industry Association).
[1] Closed in late 1998.

NOTE TO READERS

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Mercury

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CANADIAN DEVELOPMENTS

Since the closure of Cominco Ltd.'s Pinchi Lake mine in 1975, Canada no longer produces mercury metal. Mercury has been primarily an imported commodity in Canada. Canadian consumption of mercury has steadily declined in recent years. In 1998, just over 2 t of mercury was consumed for applications in the electrical apparatus sector. Consumption for applications such as gold recovery, industrial chemicals, and paints and pigments has been phased out. Canada exported 8.0 t of mercury in 1998 valued at $14 000, compared to 4.3 t in 1997 worth $7000. Imports totalled 11.4 t valued at $109 000 in 1998 compared to 7.1 t worth $66 000 in 1997.

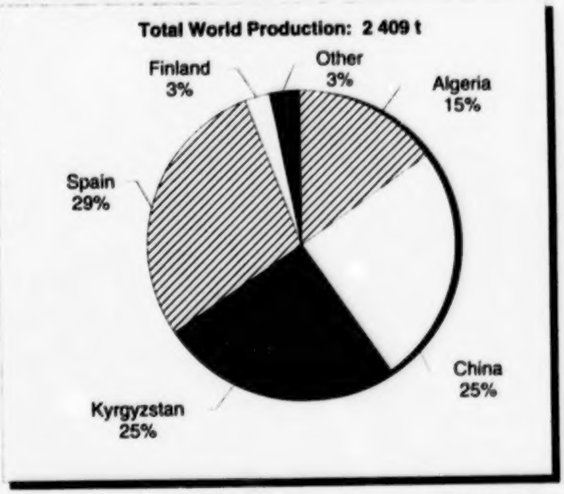
WORLD DEVELOPMENTS

World production of mercury has been declining steadily over the past few years. Total world production was 2409 t in 1997, compared with 2713 t in 1996. Spain was the world's largest producer followed by Kyrgyzstan, China and Algeria. Together these four countries accounted for just over 94% of the world's total production of mercury in 1997. Mined mercury accounts for about 60% of world consumption with the remainder supplied from recycled sources.

In the United States, about 15 t of mercury are recovered as a by-product of gold mining in Nevada, California and Utah. Secondary production greatly outweighs production from primary sources. According to the U.S. Geological Survey, the United States produced some 400 t of secondary mercury in 1997. Sales of mercury by the Defense Logistics Agency (DLA) from the National Defense Stockpile remained suspended in 1998 pending the completion of an analysis of the potential environmental impact of the sales.

Elsewhere in the world, mines in Slovenia, Turkey and the Ukraine remained closed. By-product production from mining continues in Finland, Mexico and Chile. The decommissioning of mercury chlor-alkali plants in Europe and elsewhere remains a significant source of secondary mercury. Plant closures in Finland, Norway, the United Kingdom and South Africa have contributed some 360 t since 1997. Further plant closures and conversions are planned. There are some 100 mercury cell chlor-alkali plants still in operation worldwide.

Figure 1
World Production of Mercury, 1997



Source: International Consultative Group on Nonferrous Metals Statistics.

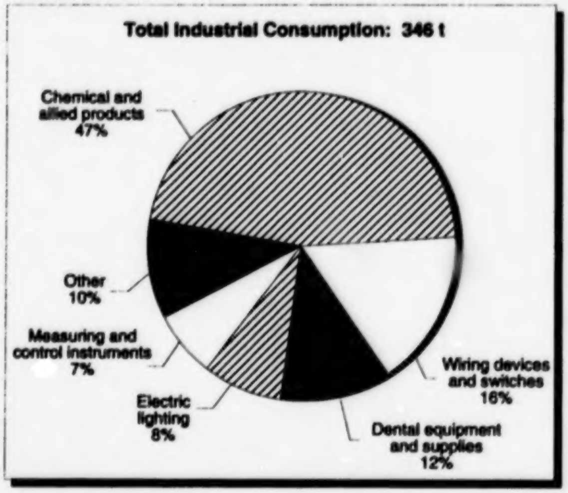
CONSUMPTION AND USES

Until the 1960s, mercury was used primarily as a flowing mercury cathode for the electrolysis of an aqueous sodium chloride solution to yield chlorine and caustic soda. Process losses to the environment became a concern and many chlor-alkali plants were either closed or converted to diaphragm cell or ion exchange technologies. Worldwide demand for this application continues to be the single largest use for

mercury, but it is declining as older facilities are being closed and replaced with mercury-free technology.

Batteries are another major market for mercury that is experiencing a decline as manufacturers switch to alternative metals. The third major use for mercury is in electrical applications. Uses range from metallic mercury switches in thermostats to mercury-vapour discharge lamps. Other uses include for mildew-proofing paint additives, and use in dental amalgams, temperature- and pressure-measuring devices, detonators, pigments and pharmaceuticals. Increased concerns related to the risks of exposure to human health and the environment have led to increased restrictions on the uses of mercury; however, its unique properties will likely guarantee its use in some key sectors for the foreseeable future.

Figure 2
U.S. Industrial Consumption of Mercury Metal, 1997



Source: U.S. Geological Survey.

Mercury is a naturally occurring element that is unique amongst the metals in that it is liquid at ambient temperature. At room temperature, mercury is a silvery white colour. It is solid white below its melting point of -38.9°C, and is a colourless gas above its boiling point of 356.9°C. Mercury exists in nature in some 25 different minerals, but is most commonly recovered from the red sulphide mineral known as cinnabar (HgS).

Other common mercury ores include corderoite and livingstonite. Native mercury metal exists in nature but is rare. Mercury deposits are generally formed at relatively low temperatures in the world's major orogenic belts.

PRICES AND OUTLOOK

The commercial unit for handling mercury is the "flask," which weighs 34.47 kg (76 lb). Prices for mercury peaked in 1988 at US$335.52/flask and have since declined. Mercury prices reached their lowest level in September 1991 at US$85/flask. North American mercury prices started 1998 at US$180-$195/flask, but declined steadily throughout the year to end in the $165-$185/flask ange, for a year-end average of about $180/flask (for lots sold containing 50 flasks or more). In Europe, prices continued to reflect the oversupplied market from Eastern European sources, trading in the $US135-$145/flask range at year-end. North American prices are expected to remain in the $160-$180/flask range in 1999. In the longer term, prices are expected to remain relatively stable as demand in mercury's remaining markets stabilizes.

Note: Information in this review was current as of January 29, 1999.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2617.90.00.90	Mercury ores and concentrates	Free	Free	Free	Free
2805.40	Mercury	Free	Free	Free	Free
2825.90.10.20	Mercury oxides	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999.

TABLE 1. CANADA, MERCURY TRADE, 1996-98, AND CONSUMPTION, 1995-97

Item No.		1996		1997		1998p	
		(kilograms)	($000)	(kilograms)	($000)	(kilograms)	($000)
EXPORTS							
2805.40	Mercury						
	United States	137 065	1 090	4 264	7	8 037	14
	Total	137 065	1 090	4 264	7	8 037	14
IMPORTS							
2617.90.00.90	Mercury ores and concentrates	–	–	–	–	–	–
	Total	–	–	–	–	–	–
2805.40	Mercury						
	United States	5 291	48	6 855	63	10 494	101
	Germany	24	. . .	218	3	280	2
	Other countries	114	1	51		609	6
	Total	5 429	49	7 124	66	11 383	109
2825.90.10.20	Mercury oxides						
	United States	138r	3	393	8	344	6
	Germany	118	2	35	1	119	2
	Other countries	–	–	17	. . .	3	. . .
	Total	256r	5	445	9	466	8

	1995	1996	1997p
		(kilograms)	
CONSUMPTION[1] (metal)			
Electrical apparatus, industrial and control instruments	x	x	x
Electrolytic preparation of chlorine and caustic soda and other uses	x	x	x
Total	2 985	6 327	x

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . . Amount too small to be expressed; p Preliminary; r Revised; x Confidential.
[1] Available data as reported by consumers.
Note: Numbers may not add to totals due to rounding.

TABLE 2. AVERAGE MERCURY PRICES, 1997 AND 1998

	New York	
	1997	1998
	(US$/flask)	
January	233.98	187.00
February	232.76	187.00
March	210.00	187.00
April	228.64	187.00
May	220.00	187.00
June	199.05	181.55
July	200.00	175.00
August	198.10	175.00
September	190.83	175.00
October	198.83	175.00
November	191.47	175.00
December	187.00	175.00
Yearly average	207.56	180.55

Source: *American Metal Market.*

TABLE 3. WORLD PRODUCTION OF MERCURY, 1994-97

Country	1994	1995	1996	1997p
		(tonnes)		
Algeria	414.0	292.0	368.0	370.0
Chile	70.1	9.0	5.0	5.0
China e	467.0	779.0	510.0	600.0
Finland	90.0	90.0	88.0	63.0
Kyrgyzstan e	379.0	380.0	584.0	611.0
Mexico	12.0	15.0	15.0	15.0
Spain	393.0	1 497.0	1 053.0	690.0
Tajikistan e	55.0	50.0	45.0	40.0
Ukraine e	50.0	40.0	30.0	–
United States	15.0	15.0	15.0	15.0
Total world	1 945.1	3 167.0	2 713.0	2 409.0

Sources: Natural Resources Canada; International Consultative Group on Nonferrous Metals Statistics.
– Nil; e Estimated; p Preliminary.

Mineral Aggregates

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Total Canadian shipments of mineral aggregates (mostly crushed stone, and sand and gravel, but excluding limestone used to process cement and lime) amounted to approximately 289 Mt in 1998. This amount is about 8% lower than in 1997, based on preliminary figures.

Increased demand for aggregates is expected in 1999 based on expansions in the residential and non-residential construction sectors. Unit values generally continued to increase in pace with the rate of inflation, with selling prices varying considerably depending on proximity to consumers. Additional detailed information relating to all types of stone, including limestone, granite, marble, sandstone and shale, is included in a separate chapter entitled *Stone*. Tariffs for nearly all stone products are free; details are listed in the *Stone* chapter.

The $6 billion cost-shared program for infrastructure renewal, supported by all three levels of government, has contributed to total construction activity in Canada. Related program expenditures will be discontinued in the 1998/99 fiscal year.

Trade in aggregates, mainly with the United States, is minimal in most regions of Canada. However, the new six-year *Transportation Equity Act for the 21st Century* is expected to result in additional export opportunities for some strategically located Canadian quarries.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of February 1, 1999.

TABLE 1. CANADA, TOTAL PRODUCTION OF STONE, 1996-98

	1996		1997		1998p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
BY PROVINCE[1]						
Newfoundland	1 652r	15 442r	2 336	20 974	2 056	17 361
Nova Scotia	6 260	35 726	7 764	45 523	5 768	34 556
New Brunswick	4 691	23 539	3 934	20 293	3 175	19 256
Quebec	30 008r	188 855r	29 043	187 544	28 609	192 871
Ontario	39 620	267 710	44 839	299 792	45 304	307 677
Manitoba	3 298	14 422	4 249	18 718	4 181	19 983
Alberta	549	6 174	591	6 698	537	6 274
British Columbia	6 050	39 483	6 266	43 497	6 125	47 086
Northwest Territories and Yukon	203	1 195	243	1 123	244	1 132
Total	92 331r	592 547r	99 265	644 162	95 998	646 198
BY USE[2]						
Dimensional stone						
Rough	232	28 853	285	30 799	. .	. .
Monumental and ornamental stone (n.f.)	53	7 111	54	6 356	. .	. .
Other (flagstone, curbstone, paving blocks, etc.)	39	3 327	54	6 186	. .	. .
Lining open-hearth furnaces	–	–	–	–	. .	. .
Chemical and metallurgical						
Cement plants, Canada	14 390	44 589	14 731	45 065	. .	. .
Cement plants, foreign	1 725	7 477	1 747	8 234	. .	. .
Flux in iron and steel furnaces	297	2 178	332	2 154	. .	. .
Flux in nonferrous smelters	164	915	158	1 046	. .	. .
Glass factories	146	2 700	181	2 850	. .	. .
Lime plants, Canada	4 828	27 045	4 285	26 276	. .	. .
Lime plants, foreign	115	700	447	2 503	. .	. .
Pulp and paper mills	134	1 558	117	1 216	. .	. .
Sugar refineries	16	68	–	1	. .	. .
Other chemical uses	1 570	9 638	1 902	11 854	. .	. .
Pulverized stone						
Whiting	40	2 879	44	3 250	. .	. .
Asphalt filler	139	198	164	226	. .	. .
Dusting coal mines	4	233	4	286	. .	. .
Agricultural purposes and fertilizer plants	946	15 545	1 078	15 617	. .	. .
Other uses	847	26 949	875	32 838	. .	. .
Miscellaneous stone						
Manufacture of artificial stone	465	2 182	8	291	. .	. .
Roofing granules	487	22 609	450	21 290	. .	. .
Poultry grit	133	1 595	167	1 848	. .	. .
Stucco dash	19	3 201	20	2 355	. .	. .
Terrazzo chips	4	365	4	179	. .	. .
Rock wool	4	29	34	571	. .	. .
Rubble and riprap	1 163	6 057	693	3 032	. .	. .
Other uses	1 416	11 443	1 869	16 489	. .	. .
Crushed stone for						
Concrete aggregate	9 803	56 521	12 631	72 511	. .	. .
Asphalt aggregate	10 681	60 754	12 559	75 803	. .	. .
Road metal	36 480	189 602	35 137	180 657	. .	. .
Railroad ballast (includes traprock)	1 393	11 090	1 563	13 783	. .	. .
Other uses	24 675	119 843	27 674	133 230	. .	. .
Total	112 409	667 254	119 267	718 792	. .	. .

Sources: Natural Resources Canada; Statistics Canada.
. . Not available; n.f. Not finished or dressed; p Preliminary.
1 Data exclude stone used in the Canadian cement and lime industries. 2 Data include stone used in the Canadian cement and lime industries.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, PRODUCTION OF SAND AND GRAVEL[1] BY PROVINCE, 1996-98

	1996		1997		1998p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Newfoundland	2 010	11 269	2 426	11 719	2 430	11 762
Prince Edward Island	316	1 277	240	1 006	240	1 006
Nova Scotia	4 245	16 190	3 236	13 921	3 263	13 925
New Brunswick	4 288	x	4 183	x	4 075	x
Quebec	29 537	81 944	31 274	82 562	24 439	67 881
Ontario	86 571	321 079	90 515	337 137	91 308	342 559
Manitoba	8 803	x	10 798	x	10 497	x
Saskatchewan	9 279	x	10 750	x	10 933	x
Alberta	30 141	118 221	36 607	147 200	36 777	154 457
British Columbia	35 674	149 741	32 999	151 869	31 345	146 223
Yukon	1 309	4 984	914	3 045	868	2 932
Northwest Territories	1 657	6 488	1 553	3 963	1 475	3 816
Total	213 831	772 590	225 495	829 190	217 650	819 893

Source: Natural Resources Canada.
p Preliminary; x Confidential.
[1] Production represents shipments of natural gravel, sand and crushed gravel. Does not include shipments to Canadian cement plants.
Note: Numbers may not add to totals due to rounding.

TABLE 3. AVAILABLE DATA ON CONSUMPTION OF SAND AND GRAVEL, BY PROVINCE, 1996 AND 1997

		Atlantic Provinces	Quebec	Ontario	Western Provinces[1]	Canada
				(000 tonnes)		
Road bed, surface	1996	6 078	17 717	45 854	44 368	114 017
	1997	5 281	19 091	44 020	47 896	116 287
Roads, ice control	1996	472	988	2 686	1 641	5 786
	1997	329	1 007	2 515	1 334	5 184
Concrete aggregate	1996	1 447	3 067	10 349	13 287	28 150
	1997	1 587	3 461	12 831	14 650	32 530
Asphalt aggregate	1996	1 246	3 527	7 022	6 987	18 782
	1997	1 035	3 260	8 497	7 195	19 987
Railroad ballast	1996	170	30	12	362	574
	1997	5	2	6	319	332
Mortar sand	1996	58	233	756	247	1 295
	1997	32	337	919	261	1 549
Backfill for mines	1996	. . .	38	1 483	84	1 606
	1997	. . .	38	1 299	168	1 504
Fill	1996	836	1 873	7 671	6 137	16 517
	1997	1 100	1 796	7 776	7 834	18 506
Other purposes	1996	604	2 064	11 183	14 310	28 162
	1997	755	2 282	12 814	14 177	30 029
Total	1996	10 911	29 537	87 017	87 423	214 889
	1997	10 123	31 274	90 677	93 834	225 908

Source: Natural Resources Canada.
. . . Amount too small to be expressed.
[1] The western provinces include the Yukon and Northwest Territories.
Note: Numbers may not add to totals due to rounding.

TABLE 4. CANADA, EXPORTS AND IMPORTS OF SAND AND GRAVEL AND CRUSHED STONE, 1996-98

Item No.		1996		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
EXPORTS							
2505.90	Natural sands n.e.s., excluding metal-bearing sands						
	United States	123 235	1 771	298 640	2 856	333 040	3 735
	Thailand	–	–	–	–	11 594	116
	Bermuda	18 748	201	13 352	241	7 691	76
	Bahamas	51 407	1 271	27 182	507	–	–
	France	–	–	5 948	46	–	–
	Jamaica	–	–	101 178	2 033	–	–
	Other countries	2 682	221	–	–	252	92
	Total	196 072	3 464	446 300	5 683	352 577	4 019
2517.10	Pebbles, gravel, broken or crushed stone used for aggregates, etc.						
	United States	2 625 312	19 227	3 102 466	24 140	3 068 452	27 365
	Bahamas	–	–	18 261	412	34 021	727
	Bermuda	17 912	298	13 155	129	25 927	462
	Suriname	–	–	–	–	32 620	414
	Guyana	–	–	16 832	173	19 181	231
	Turkey	9 245	66	2 341	188	–	–
	Estonia	–	–	501	220	–	–
	Other countries	93 154	488	75 456	454	14 712	111
	Total	2 745 623	20 079	3 229 012	25 716	3 194 913	29 310
2517.41	Marble granules, chippings and powder of 25.14 or 25.16, heat-treated or not						
	United States	31 778	3 556	128 601	17 558	244 565	27 251
	France	–	–	1 178	135	8	24
	Norway	–	–	5 587	582	–	–
	Total	31 778	3 556	135 366	18 275	244 573	27 275
2517.49	Granules, chippings and powder, n.e.s., of 25.15 or 25.16, heat-treated or not						
	United States	113 179	697	1 311	118	1 638	158
	Other countries	–	–	154	20	94	48
	Total	113 179	697	1 465	138	1 732	206
2518.10	Dolomite, not calcined						
	United States	592 098	3 956	707 573	4 489	967 762	9 075
	Trinidad and Tobago	25 292	292	–	–	–	–
	Other countries	2	12	228	59	–	–
	Total	617 392	4 260	707 801	4 548	967 762	9 075
2518.20	Calcined dolomite						
	United States	33 827	6 346	33 620	6 390	32 515	6 459
	Venezuela	26 422	887	26 602	355	–	–
	Trinidad and Tobago	–	–	50 559	670	–	–
	Other countries	562	135	40	11	–	–
	Total	60 811	7 368	110 821	7 426	32 515	6 459
2518.30	Agglomerated dolomite (including tarred dolomite)						
	Other countries	–	–	–	–	–	–
	Total	–	–	–	–	–	–
2521.00	Limestone flux; limestone and other calcareous stone used for lime or cement						
	United States	2 408 555	14 577	2 523 677	14 552	2 765 101	21 587
	Other countries	810	4	–	–	20	15
	Total	2 409 365	14 581	2 523 677	14 552	2 765 121	21 602
IMPORTS							
2505.90	Natural sands n.e.s., excluding metal-bearing sands						
	United States	227 944	4 734	288 537	6 568	310 396	8 395
	India	–	–	–	–	414	66
	United Kingdom	1 628	46	1 239	42	2 632	58
	France	128	36	13	3	146	47
	Philippines	193	6	55	26	111	42
	Australia	186	53	467	131	356	26
	Other countries	544r	81r	6 076	61	280	47
	Total	230 623r	4 956r	296 387	6 831	314 335	8 681

TABLE 4 (cont'd)

Item No.		1996		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
IMPORTS (cont'd)							
2517.10	Pebbles, gravel, broken or crushed stone used for aggregates, etc.						
	United States	3 321 390r	16 545r	3 278 576	17 240	3 219 228	18 764
	China	–	–	6 207	54	16 077	141
	United Kingdom	1 538	23	1 880	26	461	28
	Philippines	–	–	1 072	11	1 508	18
	Other countries	2 939	48	1 467	55	2 890	34
	Total	3 325 867r	16 616r	3 293 202	17 386	3 240 164	18 985
2517.20	Macadam of slag, dross or similar industrial waste, etc.						
	United States	–	–	907	3	5 745	45
	Other countries	–	–	162	1	133	1
	Total	–	–	1 069	4	5 878	46
2517.30	Tarred macadam						
	United States	7	1	550	26	1 149	47
	Total	7	1	550	26	1 149	47
2517.41	Marble granules, chippings and powder of 25.15 or 25.16, heat-treated or not						
	United States	68 167	9 674	78 568	12 646	103 938	17 120
	France	174	34	373	44	1P1	38
	Other countries	129	21	163	25	59	12
	Total	68 470	9 729	78 104	12 715	104 178	17 170
2517.49	Granules, chippings and powder, n.e.s., of 25.15 or 25.16, heat-treated or not						
	United States	146 632	1 707	77 198	1 906	38 485	1 588
	Greece	–	–	–	–	1 334	72
	France	4 025	233	527	60	570	68
	Brazil	30	4	21	2	103	10
	Mexico	64 555	1 001	9	1	33	3
	Other countries	62	7	242	17	51	3
	Total	215 304	2 952	77 997	1 986	40 576	1 744
2518.10	Dolomite, not calcined						
	United States	3 150	459	2 711	504	2 634	499
	Other countries	–	–	8	2	10	2
	Total	3 150	459	2 719	506	2 644	501
2518.20	Calcined dolomite						
	United States	4 113	866	6 459	952	2 946	584
	Canada	–	–	–	–	143	13
	Total	4 113	866	6 459	952	3 089	597
2518.30	Agglomerated dolomite (including tarred dolomite)						
	United States	22	12	10	4	100	28
	Total	22	12	10	4	100	28
2521.00	Limestone flux; limestone and other calcareous stone used for lime or cement						
	United States	2 523 290	13 334	3 210 105	15 160	3 868 166	17 656
	Other countries	38 597	127	7 467	36	11 592	33
	Total	2 561 887	13 461	3 217 572	15 196	3 879 758	17 689

Source: Statistics Canada.
– Nil; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified; p Preliminary; r Revised.
Note: Numbers may not add to totals due to rounding.

TABLE 5. LIGHTWEIGHT AGGREGATE PRODUCERS IN CANADA, 1997

Company	Location	Commodity	Remarks
ATLANTIC PROVINCES			
Fafard Peat Moss Company Ltd.	Shippagan, N.B.	Perlite, vermiculite	Processed for use in horticulture.
Sun Gro Horticulture Canada Ltd.	Maisonnette, N.B.	Perlite	Processed for use in horticulture.
QUEBEC			
Premier Peat Moss Ltd.	Rivière du Loup	Perlite, vermiculite	Processed for use in horticulture.
Vermi-lite Inc.	Baie-du-Febvre	Perlite, vermiculite	Processed for use in horticulture.
ONTARIO			
Grace Canada, Inc.	Ajax	Vermiculite, perlite	Vermiculite processed for use in horticulture, as loose insulation, and in friction materials. Perlite processed for use in gypsum plaster, horticulture, refractories and as loose insulation.
National Slag Limited	Hamilton	Slag	Used in concrete products industry and as fill.
V.I.L. Vermiculite Inc.	Woodbridge Lachine, Que. (plant)	Vermiculite, perlite	Vermiculite processed for use in loose insulation, horticulture and concrete products. Perlite processed for use in horticulture.
PRAIRIE PROVINCES			
Cindercrete Products Limited	Saskatoon, Sask.	Expanded clay	Processed for concrete products industry.
Grace Canada, Inc.	Winnipeg, Man.	Vermiculite, perlite	Perlite processed for use in gypsum plaster and in horticulture.
	Edmonton, Alta.	Vermiculite, perlite	Vermiculite processed for use in horticulture and as loose insulation.
Inland Cement Limited	Calgary, Alta.	Expanded shale	Processed for concrete products industry and for loose insulation.
	Edmonton, Alta.	Expanded clay	Processed for concrete products industry, loose insulation, and horticulture.
Sun Gro Horticulture Canada Ltd.	Elma, Man.	Perlite	Processed for use in horticulture.
Sun Gro Horticulture Canada Ltd.	Seba Beach, Alta.	Perlite, pumice	Processed for use in horticulture.
BRITISH COLUMBIA			
Canada Pumice Corporation	Abbotsford	Pumice	A range of pumice products for construction.
Great Pacific Pumice Inc.	Vancouver	Pumice	Used in horticulture and concrete products industry.
Ocean Construction Supplies Limited	Vancouver	Pumice	Purchased for concrete products industry.

Source: Natural Resources Canada, reported from NRCan survey questionnaire "Production of Lightweight Aggregates in Canada."

TABLE 6. CANADA, IMPORTS AND EXPORTS OF VERMICULITE, PERLITE AND PUMICE, 1996-98

Item No.		1996		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
EXPORTS							
2513.11	Pumice stone, crude or in irregular pieces, including crushed pumice						
	United States	84	18	170	31	443	76
	Total	84	18	170	31	443	76
2513.19	Pumice stone, other						
	United States	–	–	21	4	–	–
	Total	–	–	21	4	–	–
IMPORTS							
2513.11	Pumice stone, crude or in irregular pieces, including crushed pumice						
	United States	3 338	599	4 182	643	4 841	756
	Turkey	4 345	646	5 076	700	3 450	528
	Greece	96	12	26	2	337	94
	Other countries	224	47	58	14	435	89
	Total	8 003	1 304	9 342	1 359	9 063	1 467
2513.19	Pumice stone, other						
	United States	2 981	872	2 364	482	2 815	578
	Other countries	1 103	226	458	99	574	117
	Total	4 084	1 098	2 822	581	3 389	695
2530.10.00.10a	Vermiculite, unexpanded						
	South Africa	12 407	2 806	13 115	3 029	12 293	3 110
	United States	8 010	1 391	9 044	1 479	10 894	1 806
	Greece	3 327	292	3 332	320	3 518	333
	Other countries	1 400	228	–	–	60	12
	Total	25 144	4 717	25 491	4 828	26 765	5 261
2530.10.00.20b	Perlite, unexpanded						
	United States	32 506	4 670	30 340	4 764	27 157	5 058
	Greece	5 993	548	12 413	1 259	17 094	2 037
	Other countries	600	40	28	3	3	. . .
	Total	39 099	5 258	42 781	6 026	44 254	7 095
3802.90.00.20c	Activated perlite, excluding expanded perlite ground to be employed in filtering						
	United States	115	83	350	235	413	219
	Other countries	–	–	38	42	–	–
	Total	115	83	388	277	413	219
6806.20.00.10	Exfoliated (expanded) vermiculite						
	United States	201	430	225	661	326	1 237
	South Africa	5	10	1	2	2	5
	Total	206	440	226	663	328	1 242
6806.20.00.20	Expanded perlite						
	United States	5 865r	3 984r	6 740	4 297	9 012	5 892
	Germany	–	–	4	3	13	9
	Total	5 865r	3 984r	6 744	4 300	9 025	5 901

Source: Statistics Canada.
. . . amount too small to be expressed; – Nil; p Preliminary.
Note: Numbers may not add to totals due to rounding.
a Data for previous years were included under code 2530.10.10.10. b Data for previous years were included under code 2530.10.10.20.
c Data for previous years were included under code 3802.90.20.

TABLE 7. CANADA, LIGHTWEIGHT AGGREGATES PRODUCED, SOLD AND USED, 1996 AND 1997

	1996				1997			
	Produced		Sold and Used		Produced		Sold and Used	
	(m^3)	($)	(m^3)	($)	(m^3)	($)	(m^3)	($)
From domestic and/or imported raw materials								
Expanded clay, shale and slag[1]	177 348	5 390 690	150 390	4 980 329	205 861	6 931 806	185 435	6 153 926
From imported crude materials								
Expanded perlite and exfoliated vermiculite[1]	500 367[r]	24 753 110[r]	524 621[r]	25 999 872[r]	484 830	24 582 603	515 641	26 182 462
Total	677 715[r]	30 143 800[r]	675 011[r]	30 980 201[r]	690 691	31 514 409	701 076	32 336 388

Source: Natural Resources Canada, reported from NRCan survey questionnaire "Production of Lightweight Aggregates in Canada" (see Table 5 for list of establishments surveyed).
[r] Revised.
[1] Combined to avoid disclosing confidential company data.

TABLE 8. CANADA, SALES OF EXPANDED SLAG, PERCENTAGE BY END USE, 1995-97

Use	1995	1996	1997
		(%)	
Concrete block manufacture	85.0	96.0	74.5
Ready-mix concrete	4.0	4.0	3.3
Miscellaneous uses	11.0	–	22.2

Source: Natural Resources Canada, reported from NRCan survey questionnaire "Production of Lightweight Aggregates in Canada."
– Nil.
Notes: See Table 5 for list of establishments surveyed.
Sales also imply quantities consumed for own use.

TABLE 9. CANADA, SALES OF EXPANDED CLAY AND SHALE, PERCENTAGE BY END USE, 1995-97

Use	1995	1996	1997
		(%)	
Concrete block manufacture	49.8	43.7	54.0
Loose insulation	47.1	51.6	41.6
Ready-mix concrete	2.0	2.0	2.9
Precast concrete manufacture	0.6	1.8	1.5
Horticulture and miscellaneous uses	0.5	0.9	–

Source: Natural Resources Canada, reported from NRCan survey questionnaire "Production of Lightweight Aggregates in Canada."
– Nil.
Notes: See Table 5 for list of establishments surveyed.
Sales also imply quantities consumed for own use.

TABLE 10. CANADA, SALES OF EXPANDED PERLITE, PERCENTAGE BY END USE, 1995-97

Use	1995	1996	1997
		(%)	
Horticulture and agriculture	92.2	94.2	92.0
Loose insulation and miscellaneous uses	7.3	3.1	7.3
Insulation			
in gypsum products	0.5	2.8	0.8
in other construction materials	–	–	–

Source: Natural Resources Canada, reported from NRCan survey questionnaire "Production of Lightweight Aggregates in Canada."
– Nil.
Notes: See Table 5 for list of establishments surveyed. Sales also imply quantities consumed for own use.

TABLE 11. CANADA, SALES OF EXPANDED VERMICULITE, PERCENTAGE BY END USE, 1995-97

Use	1995	1996	1997
		(%)	
Horticulture	83.6	86.1	86.1
Loose insulation	8.2	2.4	2.1
Miscellaneous uses	8.2	11.5	11.8

Source: Natural Resources Canada, reported from NRCan survey questionnaire "Production of Lightweight Aggregates in Canada."
Notes: See Table 5 for list of establishments surveyed. Sales also imply quantities consumed for own use.

TABLE 12. CANADA, VALUE OF CONSTRUCTION BY TYPE, 1994-96

	1994	1995	1996
		($ millions)	
BUILDING CONSTRUCTION			
Residential	34 922	29 186	32 575
Industrial	3 006	3 243	4 227
Commercial	6 251	6 265	6 945
Institutional	4 931	4 982	4 906
Other	1 948	2 095	2 360
Total building	51 058	45 770	51 013
ENGINEERING CONSTRUCTION			
Marine	492	445	447
Transportation	6 032	6 436	5 874
Waterworks	904	1 140	1 358
Sewage, dams, sanitary systems	1 501	1 585	1 397
Electric power	3 965	3 441	2 934
Railway, telephones	1 446	1 298	1 880
Gas and oil facilities	13 721	13 474	12 891
Other	2 325	2 803	2 495
Total engineering	30 386	30 621	29 276
Total construction	81 444	76 391	80 289

Sources: Natural Resources Canada; Statistics Canada, catalogue no. 61-223 (additional information is also available on the Internet at http://www.statcan.ca/english/Pgdb/Economy/Manufacturing/manuf18.htm or http://www.cmhc-schl.gc.ca/MkInfo/store/#nho).
Notes: Numbers may not add to totals due to rounding. Expenditures include value of new construction as well as major renovation work purchased.

Nickel

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The trend of declining nickel prices seen since March 1997 continued throughout 1998, reaching a low of US$3715/t on December 15. The effects of Asian financial problems translated into decreased demand in that region, especially in Japan. Various producers announced production cuts during the year, but these announcements did not halt the price decline. Demand declined by an estimated 10 000 t while finished nickel production increased by an estimated 6000 t relative to 1997.

CANADIAN DEVELOPMENTS

Canadian mine production of nickel (i.e., nickel contained in concentrates produced) was 200 908 t in 1998, up 11% from a revised figure of 180 624 t in 1997 (Table 1). Quebec became a nickel producer again (16 035 t) as the Raglan mine began commercial production in April. Primary nickel output in Canada was 144 323 t in 1998, compared to 131 639 t in 1997 (Table 1).

Canadian exports of nickel in 1998 were 228 000 t valued at $1.9 billion. This compares with 208 000 t in 1997 valued at $ 2.1 billion, reflecting stronger prices in 1997. Nickel matte exports accounted for 40% of nickel export earnings, unwrought unalloyed nickel for 43%, and nickel powders for 9%. Canadian imports of nickel declined to 70 000 t valued at $419 million. The main nickel import was nickel matte, accounting for 57% of nickel imports by value. When imports are subtracted from exports, the net export earnings were $1.5 billion, down slightly from 1997's value of $1.6 billion.

Falconbridge Limited operated nickel-copper mines in Sudbury, Ontario, and northern Quebec. The concentrate from the Sudbury mines was smelted in the company's smelter near Sudbury. The resulting matte was shipped to Falconbridge's Norwegian refinery where nickel, copper, cobalt and precious metals were recovered. The company also has a subsidiary in the Dominican Republic that produces ferronickel.

Falconbridge is considering new nickel projects in New Caledonia and Ivory Coast. In addition to its nickel-copper and ferronickel operations, the company has copper and zinc facilities, including mines, mills, smelters and refineries, in Ontario and Chile. Noranda Inc. owned 49.9% of Falconbridge at year-end. (Falconbridge's web site[1] is located at http://www.falconbridge.com/.)

Falconbridge's Raglan mine, which began initial production in December 1997, was officially inaugurated in mid-July. In the third quarter, the $500 million project reached its design capacity of 21 000 t/y of nickel, 5200 t/y of copper and 200 t/y of cobalt contained in concentrate. Raglan produced 16 345 t of nickel in concentrate and 4345 t of copper in concentrate in 1998. The concentrate is shipped from Deception Bay, 100 km north of the mine, to Québec City and then railed to Falconbridge's Sudbury smelter. The smelter in Sudbury produced matte containing 70 152 t of nickel and 31 658 t of copper in 1998, including material from Raglan.

Raglan's reserves were 19 Mt grading 2.85% nickel and 0.77% copper. A number of other companies have discovered various nickel deposits in the area near Raglan; when nickel prices recover, it is expected that Raglan's ability to increase production will be closely examined.

Inco Limited operates nickel mines, mills, smelters and refineries in Sudbury, Ontario, and in Thompson, Manitoba, as well as a copper smelter and refinery in Sudbury and a cobalt refinery in Port Colborne, Ontario. The company produces refined nickel in Canada and at Clydach in the United Kingdom. Inco recycles nickel-cadmium (Ni-Cd) batteries at its subsidiary, The International Metals Reclamation Company, Inc. (INMETCO), based in the United

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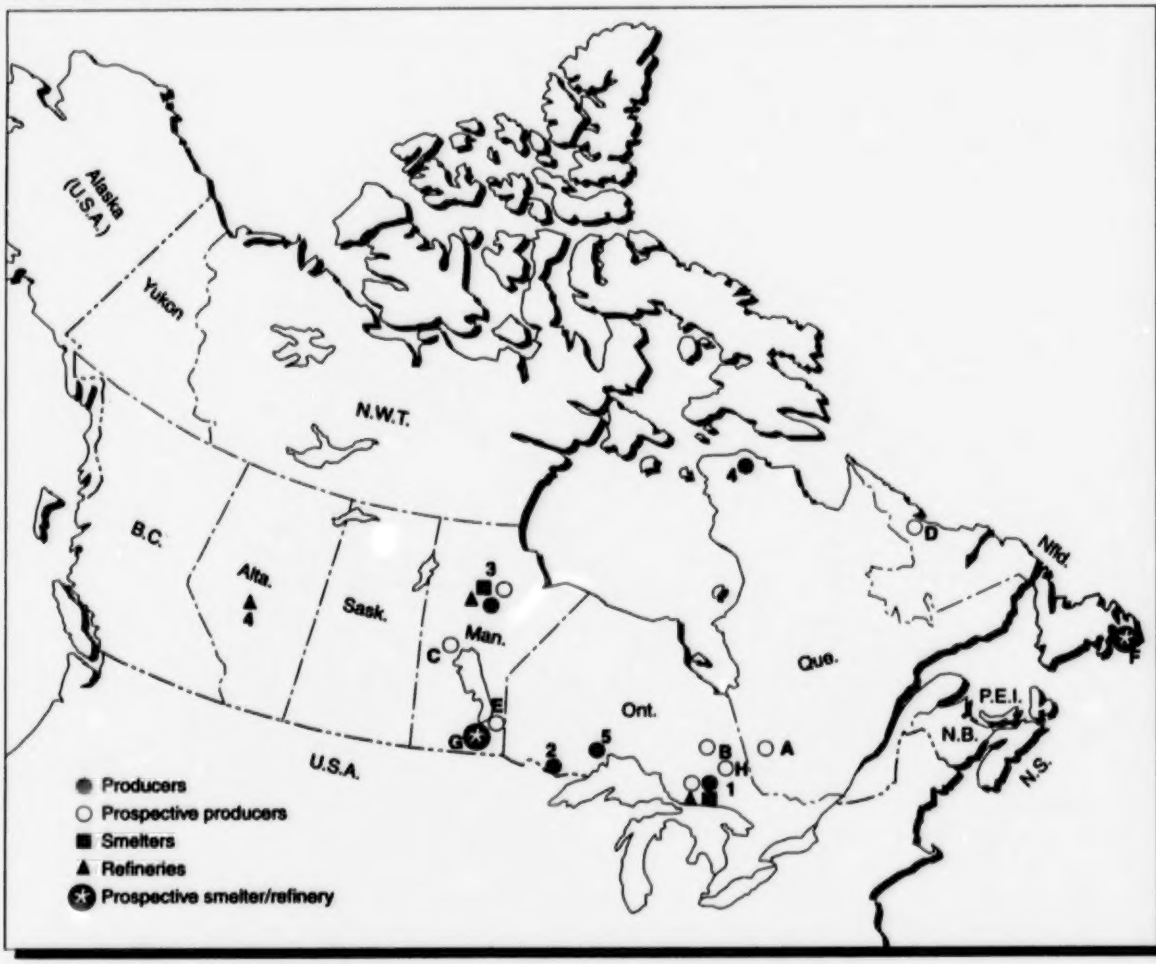
[1] The exact internet address (URL) does not include those periods, brackets, etc., that form part of the sentence's punctuation.

Figure 1
Nickel in Canada, 1998



Numbers refer to locations on map above.

PRODUCERS
1. Falconbridge Limited (Fraser, Lindsley, Onaping-Craig, Lockerby, Strathcona)
   Inco Limited (Coleman, Copper Cliff North, Copper Cliff South, Crean Hill, Creighton, Frood, Little Stobie, McCreedy East, Levack-McCreedy West, Garson, Stobie, Whistle Open-Pit)
2. Inco Limited (Shebandowan)
3. Inco Limited (Thompson, Birchtree)
4. Falconbridge Limited (Raglan)
5. North American Palladium Ltd. (Lac-des-Îles)

SMELTERS
1. Falconbridge Limited (Falconbridge)
   Inco Limited (Copper Cliff)
3. Inco Limited (Thompson)

REFINERIES
1. Inco Limited (Sudbury)
3. Inco Limited (Thompson)
4. Sherritt International Corporation (Fort Saskatchewan)

PROSPECTIVE PRODUCERS
A. Timmins Nickel Inc. (Dumont)
1. Inco Limited (Murray, Totten, Gertrude)
B. Outokumpu Mines Ltd. (Moncalm Township)
   Timmins Nickel Inc. (Langmuir)
   Black Hawk Mining Inc. (Redstone)
3. Inco Limited (Pipe No. 2)
C. Black Hawk Mining Inc. (Minago)
D. Inco Limited (Voisey's Bay mine site)
E. Canmine Resources Corporation (Maskwa)

PROSPECTIVE SMELTER/REFINERY
F. Inco Limited (Voisey's Bay smelter/refinery), Argentia
G. Gossan Resources Ltd., Selkirk (master alloy)
H. Cobatec Ltd. (cobalt)

States. It also owns 59% of a large ferronickel operation in Indonesia, P.T. International Nickel Indonesia Tbk. (P.T. Inco). Inco's other interests in Asia include: a 51% interest in Tokyo Nickel Company, Ltd. in Japan; a 49.9% interest in Taiwan Nickel Refining Corporation; a 25% interest in Korea Nickel Corporation in South Korea; and a 65% interest in the joint-venture company Jinco Nonferrous Metals Co., Ltd. in China, of which the Jinchuan Nonferrous Metals Corporation owns the remaining 35%. Inco's principal product is nickel in various forms, including premium foams and alloys. Other co-products and by-products sold by Inco include: copper, cobalt, gold, silver, platinum group metals, selenium and tellurium, sulphuric acid, and liquid sulphur dioxide. Inco has a web site at http://www.inco.com/ that also includes information about Voisey's Bay Nickel Company Limited (VBNC).

Because of objections by the U.S. Department of Justice, Inco could not sell its U.S. subsidiary Inco Alloys International, Inc. (IAI) to Haynes Holdings, Inc. Instead, Inco sold IAI to Special Metals Corporation for US$365 million before fees, taxes and expenses.

Inco announced a major capital and cost reduction program in February. By July, the company announced that it had surpassed its target of reducing costs by US$165 million per year and that cost reductions totalling US$215 million per year were possible. Also in July, Inco announced that its target for labour force reduction of 1175 had been exceeded; company officials noted that as many as 1000 additional job cuts could occur by mid-2000 to mid-2001.

To cut costs and reduce personnel, Inco shut down some mines, cut back on development at other mines, and mined higher-grade ore. The Whistle mine was closed shortly after the announcement of the cost reduction program in November 1997. Inco then shut down the Shebandowan mine near Thunder Bay, Ontario, in the first half of 1998. The scheduled closing of other mines in Ontario was announced in July. Table 10 shows the production rates for the Inco mines in the Sudbury area and their scheduled closing date, where appropriate. The Garson mine, a "marginal mine," achieved its cost-reduction target; Inco announced in October that Garson would continue to operate. There was no announcement in 1998 about the fate of the Stobie mine, another "marginal mine."

In Manitoba, Inco put the Birchtree Lower program on hold pending analysis of its competitive position. By year-end, no further information was available on the status of the Birchtree Lower program, a project that is intended to supply an important portion of the nickel feed to the Thompson smelter in the medium term.

In its second-quarter results, Inco announced plans to reduce finished nickel production at its Ontario operations from 100 000 t/y to 80 000 t/y of nickel over a two- to three-year period. In October, an Inco spokesman forecast that Inco's nickel production, including production from Indonesia, would reach 425 million lb or 192 800 t. In its report of fourth-quarter results, Inco reported total company production in 1998 at 191 603 t, of which 35 500 t was from P.T. Inco.

With the reductions in mine output, Inco has spare smelting and refining capacity available in Canada. In November, Inco entered into an agreement with Jubilee Gold Mines NL for Jubilee to supply 10 000 t/y of nickel in concentrate over three years from its Cosmos deposit. Jubilee has until September 30, 1999, to decide whether to proceed.

In December 1997, VBNC filed its Environmental Impact Statement (EIS) explaining the consequences of the construction, operation and closure of a mine, mill and associated infrastructure. On February 20, the assessment panel extended the period for comments by 30 days to March 31, 1998. On May 1, the panel announced that VBNC had not provided sufficient information in a number of areas and the panel requested further details from VBNC. That information was provided by VBNC and the panel set the period of June 1 to July 16 for interested parties to make comments to the panel. On July 30, the panel concluded that the information submitted by VBNC was adequate to support meaningful discussions of the project at public hearings. The five-person panel held public hearings at various locations in Newfoundland and Labrador from September 9 to November 6. In January 1999, the panel requested additional time to complete its report. At the time of writing, the final recommendations from the panel to the federal and provincial governments were expected to be made public at the end of March 1999. Please refer to the Canadian Environmental Assessment Agency's web site at http://www.ceaa.gc.ca/panels2/voisey/index_e.htm for more current information.

In 1997, a court action was initiated by The Citizens Mining Council of Newfoundland and Labrador to force the environmental hearing of the VBNC mine/mill project in Labrador to include an evaluation of the nickel smelter and refinery planned for Argentia in the assessment of the mine/mill. The case was heard in a Federal Court in Vancouver in March 1998. As of mid-February 1999, a decision by the Court was still pending.

Exploration at Voisey's Bay continued throughout the year. VBNC completed nearly 52 000 m of diamond drilling; exploration expenses totalled US$13 million. In addition to drilling in order to identify near-surface deposits, to investigate deep targets, and to

locate extensions to identified resources, VBNC drilled geophysical targets (such as the Red Dog grid) and started a program to drill the Kiglapait property, 60 km north of the site. A revised statement of ore reserves is shown in Table 9. An updated estimate of total resources is planned for mid-1999.

VBNC continued to negotiate separate Impact and Benefits Agreements (IBAs) with both the Labrador Inuit Association (LIA) and the Innu Nation during the first and second quarters of 1998. Negotiations were said to be principally directed at the questions of shipping schedules, shipping routes, and the financial participation of the LIA and Innu in future revenues from the deposit. During the fourth quarter, no formal IBA negotiations took place.

The province wants a commitment from Inco to build a nickel smelter and refinery, but Inco's view is that such a project is not viable, especially with low nickel prices. Part of Inco's difficulty is due to its inability to explore underground before the environmental review is completed (the result of a court decision in 1997); consequently, projects were costed upon only the Ovoid reserves. Inco announced in its second-quarter report, released in early July, that it could commit to mine only the Ovoid orebody and process the concentrates in its facilities in Ontario and Manitoba. Further processing facilities (e.g., a smelter) were to be evaluated once additional exploration was completed. At the end of July, the province broke off confidential negotiations with Inco, principally over the issue of further processing in the province. In November, the provincial government introduced amendments to *The Mineral Act*. These amendments removed ambiguities about the province's ability to require that a mine's output be smelted and refined in the province. The province also sought to reduce its exposure to legal challenge when enforcing such a requirement. The amendments became law in mid-December.

Also in December, negotiators for the Government of Canada, the Government of Newfoundland, and the LIA reached a tentative agreement on all components of an agreement in principle (AIP). As of the end of 1998, the document was subject to legal and technical review before being presented to the principals for approval. Components of the tentative AIP include aspects announced in November 1997: Labrador Inuit surface ownership of 15 700 km^2, including a 25% share of the province's resource revenues from mining and oil and gas developments on those lands; and co-management on a further 56 000 km^2 with a royalty-sharing scheme for developments on those lands. It also provides for Inuit self-government, harvesting rights and other management rights. Once the AIP has been ratified by all three parties, negotiations towards a final agreement can begin.

Sherritt International Corporation continued the debottlenecking of its nickel-cobalt refinery. Sherritt and General Nickel Company S.A. of Cuba each have a 50% interest in a joint-venture operation that operates a lateritic nickel mine in Cuba and a hydrometallurgical nickel-cobalt refinery at Fort Saskatchewan, Alberta, with a capacity of 27 000 t/y of refined nickel. The mine output is converted to sulphide concentrate in Cuba, shipped to Canada by boat, and then railed to Fort Saskatchewan for final processing. Sherritt produced 20 428 t of nickel and 1962 t of cobalt in the first nine months of 1998, up 6% from the 19 332 t of nickel produced and up 16% from the 1692 t of cobalt produced in the same period in 1997.

Dynatec Corporation is an independent, public Canadian company that now provides the metallurgical services previously offered by Sherritt International Consultants Inc. Of special significance to the nickel industry is the pressure-acid-leach (PAL) technique being commissioned by Anaconda Nickel Limited at its Murrin Murrin operation in Australia. This technology is also being adapted for potential use in New Caledonia (Calliope Minerals Corporation), the Philippines (Mighty Beaut Mineral Inc.), Indonesia, central Africa, and a number of other locations where laterite deposits are being evaluated for the commercial production of nickel and cobalt. (Additional information can be obtained from Dynatec's web site at http://www.dynatec.ca.)

North American Palladium Ltd. (NAPL) operates an open-pit palladium mine near Thunder Bay, Ontario. It produces by-product platinum, nickel, copper and gold. The mine increased its operating rate in 1997 after connecting to the provincial power grid and completing construction of a new crushing system. The mine's reported nickel production for the first nine months of 1998 was 311 t. A scoping study was under way at year-end on a proposal to expand operations from 2720 t/d (3000 st/d) to 9070 t/d (10 000 st/d) in order to process lower-grade ore. The study is expected to be completed in the first quarter of 1999. A $1.1 million exploration program was launched in 1998. Regional exploration targetted Wakinoo Lake and Buck Lake; at the mine property, an extension of the mineralized zone was identified. Additional information can be obtained from North American Palladium Ltd.'s web site at http://www.napalladium.ca/.

Cobatec Ltd., formerly Ego Resources Limited, tried to get its cobalt recovery plant in Cobalt, Ontario, into operation in 1998. During 1997, the company signed a long-term contract with Cuba to import and process cobalt-nickel sulphate precipitates from Cuba. However, after producing only minimal amounts of cobalt and nickel, the operation filed for protection under the Canadian *Bankruptcy and Insolvency Act* in October to give it time to try to restructure its finances and debt. This did not succeed and the plant was closed.

In December, Gossan Chrome Corp., a subsidiary of Gossan Resources Ltd., agreed to lease an idled 6-MW silicon smelter in Selkirk, Manitoba, from Manitoba Hydro for 15 years. The smelter will be converted to produce chrome-nickel master alloy, and the power may be increased to 9 MW. Gossan may use the furnace to process chromite from its Bird River chrome deposits near Lac du Bonnet approximately 110 km away, or could import chrome-bearing material. Gossan is expected to obtain its nickel from purchased concentrates. A master alloy containing about 5000 t/y of contained nickel would be sold to the stainless steel industry. Gossan has two renewable options on the smelter, each for 15 years, as well as an option to purchase that can be exercised during the period 2000-05. Gossan expects to spend $10 million to convert the smelter. The start-up date has not been fixed as this depends upon the outcome of the permitting process. (Gossan has a web site at http://www.gossan.ca.)

Canmine Resources Corporation announced its intention to proceed with its Maskwa deposit in Manitoba at the former Dumbarton mine site, which was operated by Maskwa Nickel Chrome Mines Ltd. Canmine must obtain a permit from the Manitoba Department of Environment before developing and opening the mine. Canmine's application to that department is expected to be filed in the second half of 1999. The indicated reserves as of the end of 1998 were 3 Mt grading 1.27% nickel and 0.21% copper, plus contained cobalt, platinum and palladium. The underground mine would have a life of 10 years if mined at a rate of 300 000 t/y. Subject to permitting, plans call for mine construction to begin in the second half of 1999 with a new 1000-t/d mill to be commissioned by early 2001. Planned output would be about 3400 t/y of contained nickel; the mill would produce separate nickel and copper concentrates. Elsewhere, Canmine will begin drilling at its BINCO nickel project located northeast and west of the Thompson Nickel Belt in Manitoba. Canmine acquired the ground in 1996 and 1997 after new aeromagnetic maps were released by the Geological Survey of Canada (part of Natural Resources Canada). The company plans to begin drilling in mid-1999, targetting a magnetic lineament that appears to run from the Thompson area in Manitoba to the Ungava Nickel Belt in northern Quebec. Drilling in 1998 at Osik Lake revealed a large ultramafic peridotite body. The company's web site is located at http://www.canmine.com.

WORLD OVERVIEW

Russia

The major nickel producer in Russia and the largest in the world is Rossiskoe Aktionernoe Obshestvo Norilsky Nikel (RAO Norilsk Nickel). This holding company has four operating subsidiaries of which the largest and most important is the Norilsk Mining and Metallurgical Combinat located in the Taymyr Region in the northern part of the Krasnoyarsk territory of Siberia. RAO Norilsk produced 219 000 t of nickel, 373 000 t of copper and 4330 t of cobalt in 1997. In the first half of 1998, production was up 6% for nickel, 1.5% for copper and 7.4% for cobalt.

Russian nickel exports to destinations outside the C.I.S. were 191 700 t for the first 11 months of 1998, down 5%, or 10 500 t, from the same period in 1997. Exports in 1997 totalled an estimated 215 000 t, of which perhaps 15 000 t likely came from stockpiles. Part of the reason for the high exports is the continued low domestic demand, which fell from 200 000 t in 1990 to 22 000 t in 1997.

RAO Norilsk needs to modernize equipment and invest in the development of new mining areas. Efforts to secure financing were complicated by the devaluation of the rouble in August, continued low nickel prices, continued responsibility for social costs in the town of Norilsk, and delays in obtaining export quotas for platinum group metals. Capital investment and refurbishment expenses in the first half of 1998 were 640 million roubles (US$106 million), or only 40% of planned investments. In November, the total investment needed at the Norilsk Combinat by 2000 was estimated at US$1.7 billion, with a further US$2.6 billion needed by 2010.

The Norilsk Combinat is accessible only by air or Arctic shipping. This integrated complex operates seven mines, two concentrators, and smelters and refineries. It produces nickel and copper cathodes, copper anodes, refined cobalt, and platinum group/precious metal concentrates. As well, the Norilsk Combinat sends nickel and copper in ore and matte to RAO Norilsk's two subsidiary operations in the Kola Peninsula for further processing. Materials are transported by Arctic shipping via the port of Dudinka on the Yenisei River. About 100 000 workers were employed at the Norilsk Combinat at the beginning of 1998. In September, management and the unions agreed to reduce employment levels to 90 000 by year-end through voluntary departures and a hiring embargo. At the end of 1996 the Norilsk Combinat employed an estimated 140 000 workers.

RAO Norilsk's Severonickel subsidiary in Monchegorsk exhausted its mine reserves in 1977. Severonikel processes nickel-copper ore and nickel matte from the Norilsk Combinat. The subsidiary's facilities include an Outokumpu flash smelter, converting facilities, and copper and nickel refineries. In June, a corporate tax collection commission ordered Severonikel to pay 250 million roubles in back taxes and 400 million roubles in fines. Severonikel disputed the claim, asserting that the government owed it about 250 million roubles in value-added tax

refunds on exports. Severonikel is the major employer for the Murmansk region and provides the region with most of the taxes paid. The back taxes and fines were beyond Severonikel's capacity to pay immediately; a compromise was reached whereby Severonikel could pay the back taxes over time. There were indications that throughput of primary matte at Severonikel could be reduced while, at the same time, the company might offset this by increasing the processing of nickel and cobalt-bearing scrap. In the spring of 1998, Severonikel obtained a tolling contract for nickel- and cobalt-bearing scrap, sludges and turnings from the United States and Europe.

The Pechanganikel subsidiary of RAO Norilsk operates four underground and open-pit mines at Zapolyarny and Nikel in the northernmost part of the Kola peninsula. Unlike those at the Norilsk Combinat, the Pechanganikel deposits do not contain platinum group metals. A concentrator handles the output from the Pechanganikel mines as well as shipments of higher-grade ore from the Norilsk Combinat. Pechanganikel's smelter at Nikel processes the concentrates to produce a copper-nickel matte that is sent to Severonikel for further processing.

There are three other separate, significant nickel producers in Russia: Ufaleynikel Joint Stock Co., the Yuzhralnikel Kombinat Joint Stock Co., and the Rezh Nickel Plant. All of these had difficulties due to the uncertainties in the Russian economy, financing difficulties, and associated problems in obtaining feed material. Their output is believed to be far below their design capacity and below their effective capacity.

Australia

The Murrin Murrin joint venture is owned 60% by Anaconda Nickel Limited and 40% by Glencore International AG. The A$1 billion Stage I plant was 70% commissioned as of mid-December, with the refinery scheduled for commissioning in January 1999. Based upon the Sherritt Acid Pressure Leach, Sulphide Precipitation, Hydrogen Reduction Process technology, Stage I is designed to produce 45 000 t/y of nickel metal and 3000 t/y of cobalt from a feed of 3.75 Mt/y. Initial mining began in March 1998 with ore being stockpiled for subsequent processing. The ore feed in the initial five years of production is estimated at 3.75 Mt/y grading 1.24% nickel and 0.13% cobalt.

During the year, additional reserves were confirmed at Murrin Murrin. The total resource base as of the third quarter of 1998 was 221 Mt grading 1.04% nickel and 0.08% cobalt. This included reserves of the higher-grade Murrin Murrin East orebody of 66.4 Mt grading 1.10% nickel and 0.1% cobalt. In August 1998, Fluor Daniel Pty Ltd. completed the feasibility study for the Stage II plant. The total capital requirement for Stage II was estimated at A$970 million (in addition to the Stage I cost). Stage II would increase the total plant output to 115 000 t/y of nickel and 9000 t/y of cobalt. The operating cost of the combined Stage I plus Stage II facility was estimated by Anaconda to be US$0.35/lb after cobalt credits (based upon cobalt prices of US$6.00/lb). The search for financing of Stage II began in 1998 and is expected to be contingent upon Stage I operating as planned.

A further expansion by Anaconda, involving the Mt. Margaret deposit with inferred resources of 176 Mt grading 0.78% nickel and 0.045% cobalt, was also examined. The plan called for a separate plant with capacity of an additional 45 000 t/y of nickel and 3500 t/y of cobalt to be commissioned in mid-2001. A feasibility study for this plan should be completed in 1999. Operating costs for the three stages (Murrin Murrin I, Murrin Murrin II, and Mt. Margaret) were estimated by Anaconda at US$0.40/lb.

Anaconda then acquired further resources in the third quarter of 1998 by entering into a joint venture with Cobra Resources NL. Anaconda will evaluate and, if feasible, develop Cobra's lateritic resources at the Three Rivers and Marlborough deposits in Queensland and at the Wowo deposit in Papua New Guinea.

In October, Anaconda and Glencore announced a takeover bid for Abednego Nickel Limited after purchasing 19.9% of Abednego shares. Abednego's deposit of an indicated mineable resource of 44 Mt grading 1.18% nickel and 0.083% cobalt is adjacent to Murrin Murrin. Abednego had planned to complete a feasibility study for an operation producing 20 000 t/y of nickel and 1900 t/y of cobalt. The takeover offer was improved and, in December, Abednego directors recommended acceptance.

Resolute Limited sold its nearly completed Bulong nickel project to Preston Resources NL in September for A$319 million. To finance the purchase, Preston's subsidiary, Bulong Operations Pty Ltd., issued US$185 million worth of senior secured notes maturing in December 2008 paying 12.5%. Despite the stated goal of having commercial metal production in October 1998, the plant had not completed commissioning by year-end due to a series of mechanical difficulties. In early 1999, the company announced its intention to produce metal by the end of February 1999. The first stage of the acid pressure leaching/solvent extraction-electrowinning plant has an initial nickel capacity of 9000 t/y and a cobalt capacity of between 700 and 1000 t/y. Plans are being studied to increase production in a possible Stage II expansion, raising the mine's throughput from 540 000 t/y to 2.5 Mt/y. This would yield about 22 000 t/y of nickel and 1500-1700 t/y of cobalt. The proven and probable reserves total 39.9 Mt grading 1.14% nickel and 0.09% cobalt within a resource of 140 Mt grading 1% nickel and 0.1% cobalt.

Centaur Mining & Exploration Limited's US$260 million Cawse project had scheduled commercial metal production for October 1998 but, by year-end, had not achieved this goal. The lateritic ore will be processed by ammonia leaching and electrowinning to produce nickel metal and a cobalt sulphide. Initial feed from higher-grade cobalt areas (grading 1% nickel and 0.68% cobalt) will allow the project to produce about 8000 t/y of nickel metal and 1400 t/y of cobalt in sulphides. Over a one- to two-year period, Centaur plans to ramp up production to between 8000 and 11 000 t/y of nickel and between 1800 and 2000 t/y of cobalt in sulphides. Ore reserves are 30 Mt grading 1% nickel and 0.06% cobalt within total resources of 210 Mt grading 0.76% nickel and 0.04% cobalt.

Preston Resources also owns the Marlborough project in Queensland (near a different deposit known by the same name held by Cobra Resources NL). The global resource at the Marlborough project was 210 Mt grading 1.02% nickel and 0.06% cobalt in 10 separate deposits. The ore can be beneficiated by screening out barren silica, thereby raising the grade of proved plus probable mine reserves to 38.5 Mt grading 1.03% nickel and 0.07% cobalt from 55.7 Mt grading 0.87% nickel and 0.07% cobalt. In September the Queensland government gave its support to the project, declaring it to be a "Major Project," which means it will be fast-tracked. Preston Resources awarded a fixed lump sum price contract of A$545 million to Multiplex Constructions Pty Ltd. for the design, construction and commissioning of the A$640 million Marlborough nickel project. Preston intends to secure financing during 1999.

Jubilee Gold Mines NL (as noted above) has the option of delivering 10 000 t/y of nickel in concentrate or ore to Inco for three years from the Cosmos deposit; Jubilee must decide by September 30, 1999, if it wishes to proceed. Cosmos has a reserve of 420 000 t grading 7.52% nickel plus cobalt. The capital cost to develop the open-pit mine was estimated at $A52 million; construction will take an estimated 36 weeks.

Titan Resources NL, which purchased the Radio Hill property from Resolute Resources Limited in 1997, opened the mine in April 1998. Proven reserves were reported to be 0.98 Mt grading 1.25% nickel, 1.82% copper and 0.11% cobalt in early 1998. Titan signed a five-year agreement with WMC Limited to sell all of its production to WMC's Kambalda smelter.

WMC operates nickel mines in Western Australia, a nickel smelter at Kalgoorlie, and a nickel refinery at Kwinana. The refinery completed its 21-day biannual maintenance shut-down in March; production in the December quarter was a record 15 808 t. The smelter was shut down for 10 days to install hoods on the nickel matte converters intended to route additional sulphur dioxide to the acid plant. The smelter, which produced 100 071 t in 1998, suffered an unplanned shut-down in the first week of 1999. Mill output reached a record 31 461 t in the September 1998 quarter. Throughout the year, WMC continued its drive to cut costs; on September 15, the company announced that three of its highest-cost mines at Kambalda would be put on care and maintenance thereby decreasing its operating capacity by 10 000 t of nickel in concentrate.

In September, Billiton plc made an offer for outstanding shares of QNI Ltd. for 30% over the then current share value. The offer was eventually accepted and QNI will be delisted from the Australian stock exchange. QNI operates a nickel refinery in Queensland that processes imported laterite ores from New Caledonia, the Philippines and Indonesia. The Townsville refinery's capacity is 30 000 t/y of nickel and 2000 t/y of cobalt. QNI also owns the Cerro Matoso ferronickel smelter in Colombia (see below).

In addition, QNI shares an interest in the Maggie Hayes and Emily Ann deposits in Western Australia with LionOre Mining International Ltd., a Canadian company based in Toronto. Subject to regulatory approvals, a plan to rationalize the Australian holdings of LionOre, QNI and Capricorn Resources Australia NL was announced in late 1998. In January 1999, the plan was amended and a new company, LionOre Australia Nickel Limited, would hold 100% of the Emily Ann deposit, 31% of the Maggie Hayes deposit, and certain options and other interests. LionOre would hold 75% of LionOre Australia and would acquire Capricorn Resources Australia NL's 25% interest in the Roundtop Joint Venture in return for LionOre Australia shares. LionOre also owns 41% of Tati Nickel Mining Company (Pty) Ltd. in Botswana (see below) and 22% of Jubilee Gold Mines NL (see above).

New Caledonia

New Caledonian mines produce about 125 000 t/y of nickel in lateritic ore. In 1998, the ore was either exported to smelters and refineries in Australia and Japan, or was processed on the island at the Doniambo smelter of Société Le Nickel-SLN (SLN) of The ERAMET Group.

Inco continued building its US$50 million, 12-t/d pilot plant at Goro to evaluate its proprietary acid pressure leaching and solvent extraction technologies for lateritic ore. The Goro deposit has reserves of 165 Mt grading 1.6% nickel and 0.16% cobalt; it is owned 85% by Inco and 15% by Bureau de Recherches Géologiques et Minières (BRGM) de France. Construction of the pilot plant is scheduled to be completed by mid-1999 after which the process evaluation will begin. An initial mining zone of 47 Mt at an undisclosed grade could supply a commercial operation with an initial capacity of 27 200 t/y of nickel and

2720 t/y of cobalt. In mid-year, Inco's chairman said that the company was considering selling a 20-30% interest in the property; this would reduce the equity that Inco would need to invest to bring the property into production.

An agreement between SLN and Société Minière du Sud Pacifique (SMSP) for exchanging ore reserves was formalized in early 1998. SMSP required larger ore reserves in order to develop a 54 000-t/y ferronickel smelter at the northern end of New Caledonia in alliance with Falconbridge. Under the terms of the agreement, SLN will give up the Koniambo deposit in return for the smaller Poum deposit and financial compensation. Compensation would be set by a commission that would evaluate the swap only after a final decision to proceed with the SMSP-Falconbridge project takes place. Unless this decision is made by January 1, 2005, the two orebodies will revert to their original owners.

In November, New Caledonian voters approved an agreement reached in 1997 allowing the territory to assume increasing autonomy over the next 15 years. A second referendum at the end of that period will allow voters to choose whether they wish to have full self-determination and independence. The power to grant exploration and mining licences will be delegated to local authorities after provincial elections in mid-1999.

In September, SLN announced that it would produce only 57 000 t of nickel compared to its capacity of 63 000 t/y, down 1000 t from the planned 1998 production. SLN plans to cut costs by 15% in three years. SLN and QNI began their feasibility study for a nickel-processing facility on the northern portion of the island. A 20 000-30 000-t/y hydrometallurgical plant to produce an intermediate carbonate nickel-cobalt using limonitic ore as feed is being considered. The intermediates could be sent to QNI's facility in Queensland and to SLN's plant at Sandouville, France, for further processing. The study was apparently delayed and the results were not released in 1998.

Vancouver-based Calliope Metals Corporation changed its plans to build a nickel refinery in Queensland to process imported lateritic ore from New Caledonia using the Sherritt process. Instead, Calliope now wishes to build the refinery at Canala in New Caledonia to process ore from the high-grade Nakety deposit nearby. Final decisions appeared to await the outcome of the commissioning of Murrin Murrin; financing was not yet negotiated by year-end.

Cuba

The Government of Cuba announced in early January 1999 that the three Cuban nickel operations had produced 68 000 t of nickel in 1998. Two of the mines are owned by the government and one is a joint venture involving Sherritt International Corporation and the Cuban government. Cuba forecasts that production in 1999 will reach 73 000 t, which is the nominal capacity of the three operations.

In 1994, Sherritt and General Nickel Company S.A. formed Metals Enterprise, a jointly owned, vertically integrated nickel-cobalt producer. Its business is carried out through three companies: Moa Nickel S.A., International Cobalt Company Inc. (ICCI), and The Cobalt Refinery Company Inc. (Refco). At the mine, lateritic ore is converted to sulphide concentrate by an acid leaching process, while the concentrate is shipped to Canada for further processing. Canada and the European Union object to the *Helms-Burton Law* (Public Law 104-114) in the United States which, among other things, restricts the entry of key Sherritt personnel into the United States and provides rights to sue in U.S. courts.

The Americas

In Brazil in June, Cia Niquel Tocantins announced that its 1998 target for nickel production of 13 000 t (set in April) would be cut to 11 500 t. The company's US$120 million expansion to 17 000 t/y was completed in April 1998; the decision to expand was taken in 1995 when high future nickel prices were forecast. Its cobalt production target was set at 360 t, compared to its capacity of 500 t/y.

At the start of September, Falconbridge announced that its subsidiary Falconbridge Dominicana, C. por A. (Falcondo) in the Dominican Republic would be shut down for three months beginning October 25. This resulted in a production cut of 8000 t/y while maintenance at the Bonao smelter and power plant was undertaken. Because the furnace had suffered corrosion problems, the plant had been running at 80% of capacity during 1998 prior to the shut-down. Hurricane Georges caused an unscheduled shut-down in late September, resulting in an additional loss of 800 t of nickel in ferronickel. Production in 1998 was 28 053 t of nickel in ferronickel, down from 32 425 t in 1997.

In the United States, Cominco Ltd. announced at the end of January 1998 that its subsidiary, Glenbrook Nickel Co., would close due to low nickel prices. The plant closed in March when ore stockpiled at the ferronickel smelter was exhausted. Production totalled about 4300 t of nickel in ferronickel.

The de-bottlenecking of QNI's Cerro Matoso operations (mine and ferronickel smelter) in Colombia continued in 1998. Capacity will be increased from 25 000 t/y of nickel in ferronickel to 35 000 t/y by the year 2000. Production was running at 9% above 1997 levels for the first 11 months of 1998. Once the debottlenecking is completed at Cerro Matoso, QNI will examine the feasibility of expanding its capacity to

55 000 t/y of nickel in ferronickel by 2002/03 at a cost of US$330 million.

Africa

Falconbridge Limited continued exploration work on the Touba-Biankouma laterite nickel property in Ivory Coast. Falconbridge is earning a 60% interest in the joint venture; the other partners are Trillion Resources Ltd. of Canada (15%) and the Government of the Ivory Coast (25%). Development plans were submitted to the Government in mid-1997. A US$15 million program of exploration and metallurgical testing took place during the 1997/98 period. (Trillion Resources has a web site at http://www.trillion-resources.com/.)

The Tati Nickel Mining Company (Pty) Ltd. is owned 42% by LionOre, 43% by Anglo American Mining Corporation of South Africa Limited, and 15% by the Government of Botswana. The estimated reserves were increased from 39.7 Mt grading 0.5% nickel to 145 Mt grading 0.34% nickel during 1998. With the increased ore reserves, the company plans to build a concentrator. Tati's smelter produces about 9000 t/y of nickel matte and ships it to the Empress refinery in Zimbabwe.

Bindura Nickel Corporation Ltd. laid off 11% of its work force, or 445 workers, in January to cut costs due to lower nickel prices. In August, Bindura announced that it would close its Epoch mine in 1998 and its Madziw mine in 1999. Over a two- to three-year period, production will be increased at the Trojan and Shanghai mines to compensate for the production losses due to closure of the other mines. The effective capacity of the smelter and refinery was increased in mid-1998 to handle 8000 t of high-grade nickel concentrate imported from Australia.

Asia

China produced an estimated 40 000 t of nickel in 1998, approximately the same as in 1997. China imports about 600 000 t of stainless steel containing about 50 000 t of nickel. The majority of China's nickel is produced by the Jinchuan Nonferrous Metals Corporation in Gansu Province.

The largest nickel producer in Indonesia is P.T. International Nickel Indonesia Tbk. (P.T. Inco), which is owned 59% by Inco Limited. During 1998, work continued on its 50% expansion to 68 000 t/y of nickel contained in matte. The expansion includes an increase in the capacity of the hydro-electric facilities to 258 MW. Targetted production for 1998 was 45 350 t, but lingering drought effects reduced actual production to 35 500 t. Higher production is expected in 1999 as the expansion is brought on line, and the plant is expected to operate at its full capacity rate of 68 000 t/y during the year 2000.

P.T. Aneka Tambang (Persero) Tbk. operates two lateritic nickel mines, one at Gee Island and one at Pomalla on Sulawesi Island, as well as two smelters with a combined capacity of 11 000 t/y on Sulawesi Island. In June, the company announced that it would close one of its smelters from August 1988 to February 1999 for maintenance and upgrading. This decreased its production forecast for 1998 to 8400 t of nickel in ferronickel. Aneka Tambang also has plans to build a third smelter with a capacity of 13 000 t/y of nickel in ferronickel. Bids were received for engineering, procurement and construction. The estimated capital cost of the project is between US$200 million and US$240 million for a plant to be commissioned in 2001. A decision on the bids is expected in the first quarter of 1999. Aneka Tambang negotiated an off-take agreement for 30% of its planned 24 000 t/y output of nickel in ferronickel. (Aneka Tambang has a web site at http://www.antam.co.id/.)

Aneka Tambang also owns 10% of the Weda Bay project, which is managed by Weda Bay Minerals Inc., a Canadian company. The prefeasibility study indicated that a mine/plant with a capacity of 30 000 t/y of nickel and 1350 t/y of cobalt could be built for US$600 million based upon the Sherritt acid-pressure leach technology. The deposit on Halmahera Island in Indonesia has an indicated resource of 63.8 Mt grading 1.51% nickel and 0.09% cobalt, including a cobalt-rich section of 10 Mt grading 0.82% nickel and 0.19% cobalt. A subsequent press release indicated that a production rate of 3 Mt/y of ore yielding 45 000 t/y of nickel and 5000 t/y of cobalt was being considered. A 3-t bulk sample was tested by Dynatec in Fort Saskatchewan and the recoveries were 98% for nickel, 96% for cobalt and 98% for scandium. The project is seeking financing for a full feasibility study. (Weda Bay's web site is at http://wedabay.com.)

Highlands Pacific Ltd. and Nord Pacific Limited completed a bankable feasibility study of the Ramu project in Papua New Guinea (PNG). The study concluded that a mine and hydrometallurgical facility with a capacity of 33 000 t/y of nickel plus 2800-3200 t/y of cobalt in salts could be built for US$838 million, including US$200 million for infrastructure. The estimated operating cost is US$1.38/lb, or US$0.41/lb after cobalt credits (based upon a cobalt price of US$10/lb). The total resource is estimated at 144 Mt grading 1.01% nickel and 0.1% cobalt; the measured and indicated resources total 72 Mt at an undisclosed grade. The PNG government has the right to obtain a 30% share in the project after sunk costs are recovered. The owners hope to commit to construction in 1999 and to see first metal production by the end of 2001. (Nord's web site is located at http://www.nordpacific.com/np-home.html, while Highlands Pacific's web site is at http://www.highpacific.com.au/.)

The continued decline in nickel prices affected the planned rehabilitation of the Nonoc lateritic mine and nickel smelter in the Philippines. Plans to reactivate the refinery, which has been shut down since 1986, using the original ammonia leach process were shelved; studies of pressure acid leaching indicated that metal recoveries could be increased from 80% or less to 90%. A bankable feasibility study began in mid-1998. Mine reserves are sufficient to sustain 20 years of operation at 3.5 Mt/y averaging 1.24% nickel and 0.12% cobalt. These reserves would be supplemented by higher-grade ore from a new mine in Manicani Island, Mindanao. The estimated rehabilitation cost is US$650 million.

In Japan where stainless steel producers reduced production due to low domestic demand and reduced exports caused by the Asian financial crisis, Japanese nickel and ferronickel producers also announced production cuts. Sumitomo Metal Mining Co., Ltd. (SMM) announced decreases in nickel and ferronickel production in early October. SMM's target output for the last six months of its fiscal year ending March 31 was 13 000 t of nickel and 7000 t of nickel in ferronickel, down from 15 000 t of nickel and 9000 t of nickel in ferronickel for the first half of the fiscal year. In late October, Nippon Yakin Kogyo Co., Ltd. cut its monthly ferronickel production from about 1050 t to approximately 750 t of contained nickel. In the same month, Nippon Steel Corporation announced that its stainless steel production in the last quarter of calendar year 1998 would be 45% below the first quarter of the year. In November, Pacific Metals Co., Ltd. announced that its ferronickel output would be cut from 26 000 t of nickel in ferronickel in the first half of the 1998/99 fiscal year to 19 000 t.

Europe

At the end of June, Outokumpu Oyj lost 10 weeks of production due to an accident at its nickel smelter in Finland. The smelting and refining facilities at Harjavalta were expected to produce over 42 000 t of nickel compared to 35 000 t in 1997. Outokumpu mines only about half of the nickel in concentrate that it smelts, most of which is obtained from its operations in Australia. The additional nickel in concentrate is obtained mostly from WMC in Australia. Outokumpu also has a 10-year agreement with Fortaleza to process 10 000 t/y of nickel matte beginning in 1998. (Outokumpu's web site can be found at http://www.outokumpu.com.)

General Mining and Metallurgical Co. S.A. (LARCO) operates a ferronickel smelter at Larymna and laterite mines in Greece. LARCO experienced operational difficulties in December 1997; these difficulties continued and LARCO lost about 2000 t of nickel production during the first quarter of 1998. At year-end 1998, LARCO reduced its operating rate to two thirds of its 18 000-t/y nickel in ferronickel capacity. The Government of Greece plans to privatize the company; tenders for expression of non-binding interest were due on February 26, 1999.

CONSUMPTION

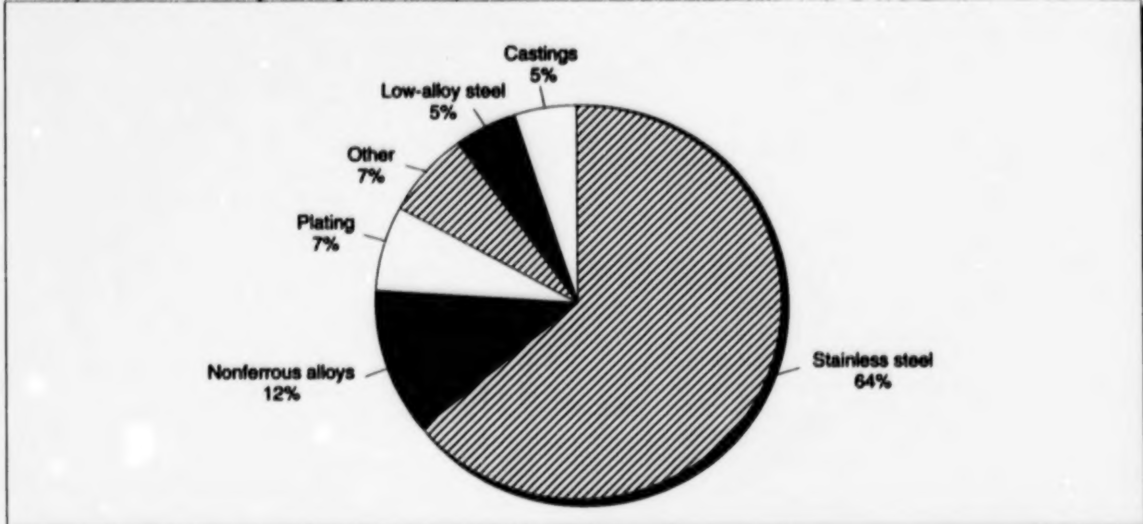
The stainless steel industry is the largest consumer of primary nickel, accounting for about two thirds of consumption. Other important consuming sectors include the nonferrous alloys, plating, low-alloy steel and foundry sectors (Figure 2). Stainless steel is "stainless" or corrosion-resistant because it contains a minimum of 10% chromium by weight. A thin film of chromium oxide adheres to the surface of stainless steel. When damaged, this film is self-healing if sufficient oxygen is present. The presence of nickel gives stainless steel superb resistance to corrosion, even in harsh operating environments. The common form of stainless steel that contains nickel is called "austenitic." Its weldability characteristics are very good, making it a good choice for construction. Austenitic stainless steel has exceptional resistance to extreme temperatures. In addition, austenitic stainless steel is very easily cleaned and therefore has excellent hygienic characteristics.

Stainless steel comes in a variety of grades and types. The most common grade is a 304 grade composed of 18% chromium and 8% nickel. While austenitic stainless steel contains nickel, ferritic stainless steel does not. A guide to these two types of stainless steel as well as others can be found at the web site of the Specialty Steel Industry of North America at the following addresses: http://www.ssina.com/stainless.html and http://www.ssina.com/student.html.

Stainless steel and high-nickel alloys are used in many applications including: gas turbines, petroleum refining, the chemical industry, the food industry, flue gas desulphurization plants, batteries (in both nickel-cadmium and nickel-metal hydride cells), liquified petroleum gas tank liners, cryogenic applications, electronics, surgical equipment, and household goods (such as cutlery, building facings and building trim). Various car manufacturers continued their work on the development of nickel-metal hydride batteries to power electric cars.

Throughout 1998, while producers made painful and public choices to shut down or cut back operations, individual consumers of nickel and stainless steel quietly and independently were finding increased applications, thereby providing a base for healthy future increases in demand. The inevitable price increase that is expected to result from a contraction of supply concurrent with an expansion of demand will be tempered by the prospect of lower-cost nickel laterite production.

Figure 2
Nickel, World Consumption by First Use, 1998



Source: Inco Limited, *Form 10-K*, year ending December 31, 1998.

HEALTH AND THE ENVIRONMENT

Nickel is a naturally occurring element that exists in soil and is believed to make up a large percentage of the earth's core. Nickel is also considered to be an essential element for plants and most animals. It has been proven to be an absolute growth requirement for certain types of bacteria and algae, and nickel deficiencies in animals have been linked to growth retardation. Besides being an essential element for plants and many animals, it is the view of many experts that nickel is likely an essential element for humans as well.

The average human body contains an estimated 7-10 milligrams of nickel, and nickel is present in human fetal tissue. Food is the major route for nickel intake by humans. Ingestion of nickel has not been shown to be either a cause of cancer in humans or a cause of nickel sensitivity. The principal health risks associated with oxidic, sulphidic and soluble nickel compounds include lung or nasal cancer and contact dermatitis.

Nickel dermatitis is caused through long-term direct or indirect contact of the skin with certain nickel-containing items that can dissolve in sweat and penetrate the skin. It is estimated that 10-20% of women and 1-2% of men are "sensitive" to nickel, with nickel dermatitis being one of the principal adverse health effects. However, many nickel alloys, including stainless steel, do not react with sweat and therefore do not cause a nickel allergy.

In the past, increased rates of lung and nasal cancers were experienced by personnel employed in certain dusty nickel-processing facilities where most of the workers involved were also exposed to other substances in the dust, and where tobacco smoking was a compounding factor.

RECYCLING

Nickel is a metal that is intensively recycled. This recycling is driven by economic incentives, not government subsidies. The major competitor for primary nickel's biggest market, stainless steel-making, is nickel in scrap. On a worldwide basis, about 45% of the nickel needed by the stainless steel industry is obtained in the form of stainless steel scrap, or an estimated 450 000 t of nickel in 1997. Stainless steel scrap not only contains nickel but also chrome and iron which are needed to produce stainless steel.

NICKEL ORGANIZATIONS

Fifteen nickel-producing and consuming nations are members of the International Nickel Study Group (INSG) based in The Hague. The Group publishes comprehensive monthly nickel statistics (refer to Table 11 for details). A new directory of nickel mines and plants, including two annual updates, is to be sold starting in mid-1999. The INSG intends to launch its web site in the first half of 1999 and the address will be http://www.insg.org.

The Nickel Development Institute (NiDI), based in Toronto, is funded by most major nickel producers. NiDI provides technical information about nickel alloys to end users and promotes new uses for nickel from offices in Toronto, London, Beijing, Tokyo, India, Australia and South Korea. The organization has a quarterly publication about applications, entitled *Nickel*, with a circulation of 35 000 in over 90 countries. It also publishes *Communiqué*, which is about regulatory developments affecting nickel, twice a year. Both are available free upon request. (NiDI has a web site at http://www.nidi.org/.)

The Nickel Producers Environmental Research Association (NiPERA) conducts and sponsors independent research into the health and environmental effects of nickel and nickel compounds. NiPERA sponsored a workshop on dermal sensitization in the spring of 1997. NiPERA is appealing a decision by a subcommittee of the National Toxicology Program in the United States, which decided in December that all compounds of nickel should be considered as known human carcinogens. NiPERA believes that subcommittee members did not have adequate access to all information about the issue and were not given correct information about the issue upon which they voted. Resolution of the matter is expected in 1999. (NiPERA has a web site at http://www.nipera.org/.)

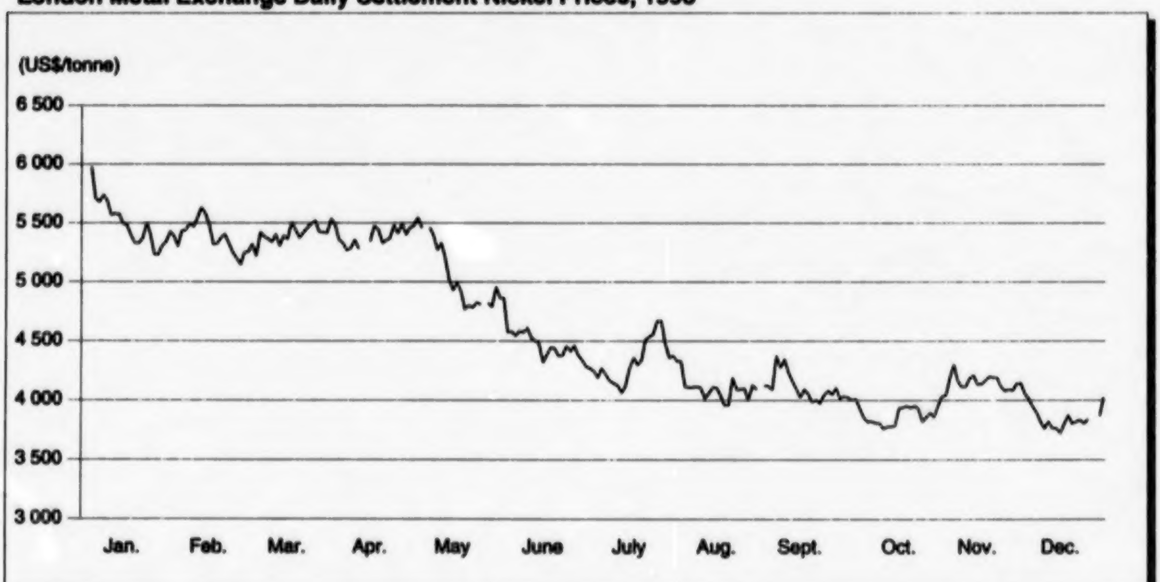
PRICES AND STOCKS

The trend of weakening nickel prices since early March 1997 continued throughout 1998. The London Metal Exchange (LME) cash settlement price declined from US$5975/t (US$2.71.lb) at the start of the year to reach its lowest point of US$3725/t (US$1.69/lb) on December 15. Figure 3 shows the daily cash settlement prices during 1998 and Figure 4 shows daily cash settlement prices for the last five years. Table 7 shows the average yearly nickel prices over the period 1981-98. Table 8 shows the average monthly prices for the period 1994-98. Historical and current LME nickel prices can be found on the Internet at http://www.lme.co.uk and at http://www.metalprices.com.

The LME changed its rules to include the Euro as a permitted currency effective January 4, 1999. Contracts in deutsche marks will not be permitted beyond a prompt date of June 30, 2002. The LME will also permit full plate nickel cathode to be delivered against nickel contracts for a standard US$100/t discount from the price for currently permitted shapes: cut cathode, pellets or briquettes. The US$100/t is said to represent the typical cost to cut cathodes, drum and deliver them to a warehouse.

LME stocks did not make dramatic moves during the year. Month-end stocks began the year at 66 500 t;

Figure 3
London Metal Exchange Daily Settlement Nickel Prices, 1998



Sources: International Nickel Study Group; Reuters; World Bureau of Metals Statistics.

Figure 4
London Metal Exchange Nickel Prices, 1994-98

Sources: International Nickel Study Group; Reuters; World Bureau of Metals Statistics.

throughout the year they varied from a low of 59 000 t for June to 66 000 t for December. No shortages of nickel metal threatened customers, although the low prices restricted the supply of nickel available in scrap, most notably in Europe.

OUTLOOK

The demand for nickel is largely a function of the demand for austenitic stainless steel and high-nickel alloy steels. Stainless steel production was estimated to have increased slightly in 1998 to approximately 16.4 Mt. The major factor in nickel and stainless steel demand is the growth in industrial production. Infrastructure growth demands heavy use of stainless steel, and development in Asia is not expected to be stalled indefinitely. The growth rate for austenitic (nickel-containing) stainless steel is expected to exceed that for ferritic (containing no nickel) stainless steel. Presently, about 74% of stainless steel output is austenitic. The demand for primary nickel is expected to continue to increase at over 3% per year on average.

The aggregate non-stainless steel demand for nickel is expected to grow much more slowly. For example, nickel use in iron and steel castings for the automotive industry is expected to decline due to substitution by lower-cost alternatives. However, the automotive industry's demand for nickel may increase rapidly from a small base at present if nickel-metal hydride batteries become the battery of choice for electric and hybrid motor vehicles.

A number of new technologies appear to be vying with each other to become the lowest-cost technology to recover nickel and cobalt from lateritic ores. Australia is the main proving ground at present; its net evaporative climate may give Australia a distinct competitive advantage in managing the residues of hydrometallurgical processing. Sherritt technology is being installed in the Murrin Murrin operation. Sherritt technology is also the choice for the proposed Calliope plant in New Caledonia. Preston Resources NL, which purchased the Bulong project in 1998, will treat ore at its Bulong project with acid pressure leaching and solvent extraction-electrowinning. Centaur will use an ammonia leach and electrowinning process. In New Caledonia, Inco intends to test its proprietary process at its Goro property starting in mid-1999.

With the associated cobalt recovery, such operations have the potential to lower the average operating costs for lateritic nickel producers and reduce overall nickel production costs, putting increased competitive pressures on the rest of the nickel industry. The success of new nickel laterite technologies would also reduce cobalt prices to the US$5-$10/lb range (some guess an even lower price), especially if a number of new cobalt deposits in the Congo also proceed.

Various producers, including Inco, Falconbridge, ERAMET, WMC and LARCO, announced cutbacks in 1998. In early 1999, WMC suffered an early shutdown of its furnace for maintenance, which cut an additional 15 000 t of production scheduled for 1999. Together, these and other cutbacks have moved the market closer to a statistical balance of supply and demand for 1999.

Nickel prices are more volatile than those of other major nonferrous metals. Part of the reason for this is that the nickel industry is very small compared to those other metals. If nickel contained in stainless steel scrap is included, total nickel consumption was about 1.5 Mt in 1998, compared to 6 Mt of lead, nearly 8 Mt of zinc, over 13 Mt of copper and 22 Mt of aluminum. Thus, the forecast for nickel is presented as a range rather than as discreet values by year.

An average nickel price of US$5510/t (US$2.50/lb) is forecast for 1999, based upon continued progress in resolving the financial problems in Asia, continued Chinese economic growth, and a moderately healthy resumption in growth of stainless steel production, but this will not be sufficient to provoke widespread restocking due to supply concerns.

The longer-term price for nickel is expected to range between US$4400-$8800/t (US$2 and $4/lb). This long-term range of average annual prices should gradually decline, by perhaps US$550-$880/t (US25¢-40¢/lb), if new lateritic production technologies operate at or near their predicted rates, recoveries and costs.

While average annual prices for any particular year are expected to fall within this projected price band, unforeseen events at production facilities could cause major supply interruptions and, consequently, substantially higher prices until supply/demand relationships are restored to more normal ranges. Such events would include serious technical problems at leading producers (e.g., extended labour or transportation problems at the Norilsk Combinat) or political problems (e.g., political problems associated with the future of New Caledonia). On the other hand, major new discoveries of high-grade orebodies should lead to a period of lower prices.

It is difficult to say if these prices should be quoted in constant dollars (i.e., inflation adjusted) or current dollars (i.e., dollars of the day). In the longer term, the decline in nickel prices in "real terms" "or constant dollars" is expected to continue because of increases in production efficiency, the application of new technologies, and competitive pressures. There seems to be little reason for changes in prices for this specific industry to mirror the general inflation rate. In the medium term, inflation rates are not expected to be significant; hence, the entry into production of large high-grade deposits or the changing patterns in demand are expected to have more of an effect on nickel prices than is the rate of inflation. In the short term, the size of the nickel inventory compared to demand and the activities of investment funds are expected to be the dominant factors.

Canadian mine production of nickel in concentrate in 1999 is forecast to rise to 205 000 t, with Raglan's output for the entire year at full production expected to more than offset the scheduled decline in Inco's output. Increased prices would allow Inco (and other producers) to restart idled capacity or to defer scheduled closings; therefore, higher prices could result in increased Canadian production. Production by Canmine could start in 2001, but it is expected to be less than 5000 t/y initially. Beyond that, the major uncertainty remains the future of the Voisey's Bay deposit.

With respect to Voisey's Bay, the report of the environmental panel is due on March 31. If the environmental panel recommends that the Voisey's Bay project may proceed with the mine and mill, obstacles still remain. The province and Inco disagree about the economics of building a smelter and refinery in the province. The province's position is that no mining licence will be issued unless a smelter and refinery are included in the proposed project. Land claims between the provincial and federal governments and the two Aboriginal groups in the area have not been completely resolved; the LIA stated in early 1999 that it would not consent to mining until a land claims agreement had been put into effect. A draft agreement in principle between the governments and the Innu Nation was not reached in 1998. Negotiations for separate impact and benefits agreements between Inco and the two Aboriginal groups have not been completed.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of mid-February 1999. (3) To obtain other web site addresses relevant to nickel, please send an e-mail request to bmccutch@nrcan.gc.ca and include the words "web sites for nickel" in the subject line of your message. (4) Various internet sites have been identified in this article. Please note that Natural Resources Canada has no control over the content of the web sites of other organizations, which may be modified, updated or deleted at any time.

NOTE TO READERS

The intent of this document is to provide general information and to elicit discussion. It is not intended as a reference, guide or suggestion to be used in trading, investment, or other commercial activities. The author and Natural Resources Canada make no warranty of any kind with respect to the content and accept no liability, either incidental, consequential, financial or otherwise, arising from the use of this document.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EU MFN	Japan[1] WTO	Brazil MFN	India MFN	Taiwan MFN	Korea[2] MFN
2604.00	Nickel ores and concentrates	Free	Free	Free	Free	Free	Free	5%	5%	Free	1%
2825.40	Nickel oxides and hydroxides	Free	Free	Free	Free	Free	5%	5-13%	30%	2.5%	8%
7202.60	Ferronickel	6.5%	Free	Free	Free	Free	3.9%	9%	20%	Free	3%
7501.10	Nickel mattes	Free	Free	Free	Free	Free	Free	9%	10%	Free	1%
7501.20	Nickel oxide sinters and other intermediate products of nickel metallurgy	Free	Free	Free	Free	Free	Free-51.40 yen/kg[3]	9%	10%	Free	1%
7502.10	Unwrought nickel, not alloyed	Free	Free	Free	Free	Free	51.40 yen/kg	9%	10%	1.25%	3%
7502.20	Unwrought nickel alloys	Free	Free	Free	Free	Free	Free-4.2%[4]	9%	10%	1.25%	3%
7503.00	Nickel waste and scrap	Free	Free	Free	Free	Free	Free	5%	10%	Free	1%
7504.00	Nickel powders and flakes	Free	Free	Free	Free	Free	Free-45.80 yen/kg-3.6%	9%	10%	Free	5%
7505.11	Bars, rods and profiles of nickel, not alloyed	Free	Free	Free	Free	0.9%	3.8%	15%	10%	2.5%	5%
7505.12	Bars, rods and profiles of nickel alloys	Free	Free	Free	Free	3.2%	3.6%	15%	10%	2.5%	5%
7505.21	Nickel wire, not alloyed	Free	Free	Free	Free	0.9%	3.8%	15%	10%	1.25%	5%
7505.22	Wire of nickel alloys	Free	Free	Free	Free	3.2%	3.6%	15%	10%	1.25%	5%
7506.00	Nickel plates, sheets, strip and foil	Free	Free	Free	Free	1-3.6%	Free-3.8%	15%	10%	2.5%	5%
7507.00	Nickel tubes, pipes, and tube or pipe fittings	Free	Free	Free	Free	1.1-2.8%	1.3-3.8%	17%	10%	2.5%	8%
7508.00	Other articles of nickel	Free-3%	Free	Free	Free	0.9%	3.6%	19%	10%	1.25-5%	8%

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999; Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of the European Union (38th Annual Edition: 1998); Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of Brazil (5th Annual Edition: 1998); Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of India (5th Annual Edition: 1998); Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of Korea (5th Annual Edition: 1998); Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of Taiwan (3rd Annual Edition: 1998); Customs Tariff Schedules of Japan, 1998, WTO column.
[1] WTO rate is shown; lower tariff rates may apply circumstantially. [2] South Korea. [3] Free except for nickel oxide sinters containing by weight not less than 88% nickel, for which the tariff rate is 51.40 yen/kg, and nickel oxide containing by weight not more than 1.5% copper, for which the tariff rate is 3.8%. [4] The tariff rate of 4.2% applies to nickel alloys other than those containing by weight less than 50% nickel and not less than 10% cobalt.

TABLE 1. CANADA, NICKEL PRODUCTION AND TRADE, 1997 AND 1998

Item No.		1997 (tonnes)	1997 ($000)	1998p (tonnes)	1998p ($000)
PRODUCTION[1]					
	All forms				
	Ontario	135 667r	1 333 875r	134 730	951 870
	Manitoba	44 958r	442 023	50 143	354 259
	Quebec	–	–	16 035	113 287
	Total	180 624r	1 775 898r	200 908	1 419 416
	Refined	131 639r	–	144 323	–
EXPORTS					
2604.00.40	Nickel ores and concentrates, nickel content				
	United States	–	–	–	3
	China	19	118	–	–
	Total	19	118	–	3
2825.40	Nickel oxides and hydroxides				
	Hong Kong	60	833	210	2 389
	United States	388	5 964	61	949
	Mexico	25	424	10	158
	Brazil	9	135	14	97
	China	188r	2 707r	7	81
	Other countries	314	4 224	–	–
	Total	984r	14 287r	302	3 674
7202.60	Ferronickel	–	–	–	–
7501.10	Nickel mattes				
	Norway	39 038	400 909	47 328	398 189
	United Kingdom	36 947	386 293	41 994	357 154
	Total	75 985	787 202	89 322	755 343

TABLE 1 (cont'd)

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
7501.20	Nickel oxide sinters and other intermediate products of nickel metallurgy				
	South Korea	6 298	52 768	9 454	87 133
	Taiwan	1 295	12 697	1 984	16 176
	United States	2 391r	21 309r	2 670	15 276
	Belgium	704	7 126	1 193	8 190
	Other countries	23	216	2	65
	Total	10 711r	94 116r	15 303	126 840
7502.10	Nickel unwrought, not alloyed				
	United States	47 557r	461 473r	52 694	413 045
	Belgium	9 719	93 700	9 365	69 642
	Italy	4 365	41 063	8 756	58 993
	Netherlands	7 057	67 826	7 560	51 254
	Taiwan	5 410r	55 592r	4 719	41 784
	China	3 857	39 760	4 974	36 974
	Hong Kong	1 427	11 883	3 227	24 018
	Japan	4 970	48 232	3 042	23 654
	Switzerland	2 688	24 515	2 862	20 367
	United Kingdom	1 537	15 003	2 389	17 117
	Singapore	2 215	21 223	1 883	14 965
	Other countries	9 797	98 033	5 539	43 512
	Total	100 599r	978 303r	107 010	815 325
7502.20	Nickel unwrought, alloyed				
	United States	286	2 513	158	1 006
	Other countries	19	59	68	221
	Total	305	2 572	226	1 227
7503.00	Nickel waste and scrap				
	United States	3 409	17 660	2 147	5 425
	Japan	363	2 410	79	782
	Other countries	246	1 358	59	541
	Total	4 018	21 428	2 285	6 748
7504.00	Nickel powders and flakes				
	United States	7 267	105 928	6 005	92 526
	Japan	4 651r	53 550r	4 577	39 918
	China	531	8 681	738	11 076
	Belgium	532	5 793	675	6 109
	United Kingdom	49	4 052	204	5 714
	Netherlands	624r	8 762r	526	4 978
	Other countries	1 448	16 486	960	11 105
	Total	15 102r	203 252r	13 685	171 426
7505.11	Bars, rods and profiles of nickel, not alloyed				
	New Zealand	78	236	–	–
	United States	–	2	–	–
	Total	78	238	–	–
7505.12	Bars, rods and profiles of nickel alloy				
	United States	2	80	14	167
	Other countries	3	49	3	39
	Total	5	129	17	206
7505.21	Nickel wire, not alloyed				
	Spain	–	–	24	157
	United States	...	10	1	25
	Total	...	10	25	182
7505.22	Wire, nickel alloy				
	United States	86	2 015	93	2 320
	United Kingdom	–	–	2	83
	Brazil	–	15	1	24
	Total	–	2 030	96	2 427

TABLE 1 (cont'd)

Item No.		1997		1998[p]	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS (cont'd)					
7506.00[a]	Nickel plates, sheets, strip and foil				
	United States	5	205	6	161
	Poland	9	102	3	34
	Other countries	21[r]	123[r]	2	18
	Total	35[r]	430[r]	11	213
7507.00[b]	Nickel tubes, pipes, and tube or pipe fittings				
	United States	. .	3 722[r]	. .	2 842
	Singapore	. .	. .	. .	172
	United Arab Emirates	. .	177	. .	95
	Other countries	. .	137	. .	199
	Total	. .	4 036[r]	. .	3 308
7508.00	Other articles of nickel				
	United States	. .	7 748[r]	. .	9 661
	Germany	. .	58	. .	90
	Japan	. .	208	. .	29
	Other countries	. .	417	. .	56
	Total	. .	8 431[r]	. .	9 836
IMPORTS[2]					
2604.00.00.20	Nickel ores and concentrates, nickel content				
	United States	1 065	6 270	1 135	6 842
	Italy	–	–	2	16
	Other countries	1 459[r]	10 651[r]	1	5
	Total	2 524[r]	16 921[r]	1 138	6 863
2825.40	Nickel oxides and hydroxides				
	Finland	330	2 222	576	9 402
	Other countries	627	591	2 197	1 862
	Total	957	2 813	2 773	11 264
7202.60	Ferronickel				
	United States	. . .	. . .	3	18
	United Kingdom	–	–	1	5
	Total	. . .	. . .	4	23
7501.00[c]	Nickel mattes, nickel oxide sinters and other intermediate products of nickel metallurgy				
	Cuba	46 723	273 743	35 178	209 629
	Australia	590[r]	6 011[r]	6 062	25 169
	United States	1 603	2 703	1 138	1 870
	United Kingdom	601	2 886	110	415
	Other countries	180	971	60	342
	Total	49 697[r]	286 314[r]	42 548	237 425
7502.10	Nickel unwrought, not alloyed				
	Norway	1 059[r]	9 173[r]	803	6 359
	United States	65	680	255	1 097
	Finland	31	338	63	675
	Russia	99	1 229	43	489
	United Kingdom	146	1 615	26	197
	Other countries	28	298	58	449
	Total	1 428[r]	13 333[r]	1 248	9 266
7502.20	Nickel unwrought, alloyed				
	Bermuda	–	–	507	2 933
	United Kingdom	17	346	44	1 015
	United States	1 115[r]	5 298[r]	146	951
	Other countries	–	16	. . .	8
	Total	1 132[r]	5 660[r]	697	4 907
7503.00	Nickel waste and scrap				
	United States	14 638	44 212	15 350	51 141
	United Kingdom	904	4 294	486	1 955
	Canada	137	789	129	1 182
	Other countries	894	3 096	675	2 261
	Total	16 573	52 391	16 640	56 539

TABLE 1 (cont'd)

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
IMPORTS[2] (cont'd)					
7504.00	Nickel powder and flakes				
	Australia	896r	9 123r	836	6 305
	United States	353	3 855	267	3 971
	Finland	202	3 011	169	1 672
	Other countries	90	1 282	229	1 458
	Total	1 541r	17 271r	1 501	13 406
7505.11	Bars, rods and profiles of nickel, not alloyed				
	United States	11	186	23	389
	Other countries	1	18	2	44
	Total	12	204	25	433
7505.12	Bars, rods and profiles of nickel alloys				
	United States	378r	7 540r	463	9 200
	Germany	19	312	15	248
	Other countries	23	458	23	398
	Total	420r	8 310r	501	9 846
7505.21	Nickel wire, not alloyed				
	United States	9	95	35	411
	Japan	19	151	18	171
	Other countries	11	166r	2	27
	Total	39	412r	55	609
7505.22	Wire, nickel alloy				
	United States	411r	7 060r	486	7 662
	Germany	69	1 363	51	1 198
	Other countries	9	178	21	429
	Total	489r	8 601r	558	9 289
7506.00	Nickel plates, sheets, strip and foil				
	United States	696r	12 127r	599	11 838
	Germany	115	2 440	182	4 432
	Japan	332	2 272	185	1 840
	Other countries	73	952	95	1 071
	Total	1 216r	17 791r	1 061	19 181
7507.00	Nickel tubes, pipes, and tube or pipe fittings				
	United States	456r	11 013r	357	9 628
	Japan	440r	26 071r	125	8 489
	Singapore	–	–	55	2 534
	Spain	332	4 711	235	2 509
	France	13	338	26	1 053
	Other countries	300	4 735	79	1 648
	Total	1 541r	46 868r	877	25 861
7508.00	Other articles of nickel				
	United States	592r	11 706r	586	11 314
	France	37	409	104	1 198
	United Kingdom	42	589	40	613
	Taiwan	4	44	42	352
	Canada	24	151	39	317
	China	94	715	19	153
	Other countries	22	333	21	280
	Total	815r	13 947r	851	14 227

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available or not applicable; . . . Amount too small to be expressed; p Preliminary; r Revised.
a Included in the data are HS codes 7506.10 and 7506.20. b Included in the data are HS codes 7507.11, 7507.12 and 7507.20.
c Included in the data are HS codes 7501.10 and 7501.20.
1 Recoverable nickel in concentrates shipped. 2 Imports from "Other countries" may include re-imports from Canada.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, NICKEL PRODUCTION AND CONSUMPTION, 1970, 1975, 1980 AND 1985-98

	Production[1] (Mine Output)	Consumption[2]
	(tonnes)	
1970	277 490	10 699
1975	242 180	11 308
1980	184 802	9 676
1985	169 971	7 206
1986	163 640	8 865
1987	193 391	9 732
1988	216 589	9 250
1989	200 899	10 421
1990	196 225	8 410
1991	192 259	13 322[a,r]
1992	186 384	15 528[r]
1993	188 080	17 384[a,r]
1994	149 886	20 746[r]
1995	181 820	20 973[r]
1996	192 649[r]	24 504[r]
1997	180 624[r]	19 447
1998[p]	200 908	. .

Source: Natural Resources Canada.
. . Not available; [p] Preliminary; [r] Revised.
[a] Increase in number of companies being surveyed.
[1] Refined nickel and nickel in oxides and salts produced, plus recoverable nickel in matte and concentrates exported. Data for 1987-98 are nickel contained in concentrates produced.
[2] Consumption of metallic nickel, all forms (refined metal, nickel in ferronickel oxides and salts, and other forms of nickel including nickel in purchased scrap) as reported by consumers on the Natural Resources Canada survey "Consumption of Nickel."

TABLE 3. CANADA, NICKEL PROCESSING CAPACITY, 1998

	Inco Limited		Falconbridge Limited	Sherritt International Corporation	Cobatec Ltd.[1]
	Sudbury	Thompson	Sudbury	Fort Saskatchewan	Cobalt
	(t/y of contained nickel)				
Smelter	100 000	63 000	70 000	n.a.	n.a.
Refinery	59 000	55 000	n.a.	27 000	450

Source: Natural Resources Canada.
n.a. Not applicable.
[1] Company bankrupt at end of 1998 and plant not operating.

TABLE 4. WORLD MINE PRODUCTION[1] OF NICKEL,[2] 1994-98

	1994	1995	1996	1997	1998•
			(000 tonnes)		
Russia	212.0	251.0	230.0	250.0	240
Canada	149.9	181.8	192.6	190.5	201
New Caledonia	97.3	120.7	124.8	137.1	128
Australia	75.9	104.0	113.0	123.4	141
Indonesia	81.2	86.6	87.9	71.1	72
Cuba	26.9	42.7	53.6	61.5	68
China	36.9	41.8	43.8	46.7	45
South Africa	30.1	29.8	33.9	34.8	36
Dominican Republic	30.8	30.9	30.4	32.5	25
Brazil	20.1	19.2	20.5	20.5	28
Other	116.2	116.0	118.7	119.6	116
Total	877.3	1 024.5	1 049.2	1 087.7	1 100

Sources: Natural Resources Canada; *World Nickel Statistics*, International Nickel Study Group, January 1999.
• Estimated.
[1] Production for 1998 has been estimated by prorating 11 months of data, except for the Dominican Republic, Canada and Cuba for which estimates for 1998 production were available. [2] Nickel content in concentrate produced (except for Russian Federation, which may refer to nickel content of ore mined).

TABLE 5. WORLD PRODUCTION[1] OF PRIMARY NICKEL, 1994-98

	1994	1995	1996	1997	1998•
			(000 tonnes)		
Russia	180.9	200.0	190.0	230.0	214
Japan	112.6	135.0	130.5	128.4	128
Canada	105.1	125.3	130.1	131.6	144
Australia	66.6	76.9	74.0	73.6	78
Norway	68.0	53.2	61.6	62.7	69
New Caledonia	39.5	42.2	42.2	44.3	44
China	31.3	38.1	44.2	39.9	42
United Kingdom	28.4	35.2	38.6	36.1	39
Dominican Republic	30.8	30.9	30.4	32.5	25
South Africa	30.1	29.8	33.9	34.8	36
Other	131.3	152.2	177.7	198.4	199
Total	824.6	918.8	953.2	1 012.3	1 018

Sources: Natural Resources Canada; *World Nickel Statistics*, International Nickel Study Group, January 1999.
• Estimated.
[1] Production for 1998 has been estimated by prorating 11 months of data, except for the Dominican Republic and Canada for which estimates of 1998 production were available.

TABLE 6. WORLD CONSUMPTION[1] OF PRIMARY NICKEL, BY COUNTRY AND BY REGION, 1994-98

	1994	1995	1996	1997	1998•
			(000 tonnes)		
BY COUNTRY					
Japan	181.1	205.1	187.1	198.3	166
United States	136.3	155.2	153.1	155.6	159
Germany	87.8	93.1	74.9	89.0	96
Taiwan	26.0	48.0	50.0	68.0	65
South Korea	39.0	44.0	50.0	66.0	63
Italy	44.0	49.0	44.0	49.5	50
United Kingdom	38.0	40.9	38.7	33.0	35
China	40.0	40.2	42.0	43.0	42
France	45.6	48.5	45.9	49.8	48
Russia	35.0	36.2	35.0	20.0	20
Other	195.4	218.0	216.8	235.8	253
Total	868.2	978.2	937.5	1 008.0	998
BY REGION					
Africa	14.9	20.6	24.8	30.0	31
Americas	170.4	190.6	189.8	189.5	195
Asia	273.1	327.0	317.0	361.5	321
Europe	326.9	353.9	318.9	352.5	375
Oceania	1.7	1.8	1.9	1.9	3
East[2]	81.2	84.3	85.3	72.6	74
Total	868.2	978.2	937.5	1 008.0	998

Source: *World Nickel Statistics*, International Nickel Study Group, January 1999.
• Estimated.
1 Consumption for 1998 has been estimated by prorating 11 months of data. 2 "East" includes China, the Czech Republic, Poland, Romania, Russia and the Ukraine.

TABLE 7. AVERAGE ANNUAL NICKEL PRICES, 1981-98

	Settlement Price	
	(US$/t)	(US$/lb)
1981	5 985	2.71
1982	4 808	2.18
1983	4 695	2.13
1984	4 783	2.17
1985	4 987	2.26
1986	3 887	1.76
1987	4 849	2.20
1988	14 206	6.44
1989	11 955	5.42
1990	8 880	4.03
1991	8 158	3.70
1992	7 000	3.18
1993	5 283	2.40
1994	6 344	2.88
1995	8 237	3.74
1996	7 500	3.40
1997	6 916	3.14
1998	4 617	2.09

Source: International Nickel Study Group, except for 1998 average, which is from *Metals Bulletin.*

TABLE 8. AVERAGE MONTHLY NICKEL PRICES, 1995-98

	1995	1996	1997	1998
		(US$/t)		
January	9 596	7 866	7 047	5 495
February	8 509	8 219	7 737	5 390
March	7 536	8 024	7 899	5 399
April	7 400	8 047	7 318	5 397
May	7 236	8 030	7 485	5 023
June	7 874	7 712	7 065	4 479
July	8 599	7 207	6 838	4 329
August	8 947	7 057	6 763	4 084
September	8 408	7 321	6 507	4 106
October	8 065	7 034	6 383	3 875
November	8 509	6 946	6 142	4 135
December	8 094	6 584	5 949	3 881
		(converted to US$/lb)		
January	4.35	3.57	3.20	2.49
February	3.86	3.73	3.51	2.44
March	3.42	3.64	3.58	2.45
April	3.36	3.65	3.32	2.45
May	3.28	3.64	3.40	2.28
June	3.57	3.50	3.20	2.03
July	3.90	3.27	3.10	1.96
August	4.06	3.20	3.07	1.85
September	3.81	3.32	2.95	1.86
October	3.66	3.19	2.90	1.76
November	3.86	3.15	2.79	1.88
December	3.67	2.99	2.70	1.76

Source: International Nickel Study Group.

TABLE 9. VOISEY'S BAY MINERAL RESERVES AND RESOURCES AS OF NOVEMBER 1998

Zone/Section	Proven Reserves	Indicated Resources	Inferred Resources	Nickel	Copper	Cobalt
		(millions of tonnes)		(%)	(%)	(%)
Ovoid	31.7			2.83	1.68	0.12
Eastern Deeps - Main Zone		47		1.39	0.6	0.09
Eastern Deeps - Far Zone		5.6		0.79	0.51	0.05
South Eastern - Extension Upper		2.6		0.83	0.46	0.04
South Eastern - Extension Lower			4.5	0.85	0.42	0.04
Discovery Hill - Upper Zone[1]		7.3		1.01	0.81	0.06
Discovery Hill - Lower Zone[1]			5.6	1.00	0.77	0.06
Reid Brook Zone		20.1		1.38	0.6	0.09
Total proven reserve	31.7			2.83	1.68	0.12
Total indicated resource		82.6		1.30	0.61	0.08
Total inferred resource			10.1	0.93	0.61	0.05
Total proven + indicated + inferred	124.4			1.66	0.88	0.09

Source: Inco Limited *Investor Fact Book*, p. 39, November 1998.
[1] Previously referred to as part of the Western Extension.

TABLE 10. INCO'S ONTARIO MINES, PRODUCTION AND STATUS AS OF NOVEMBER 1998

Mines	Annual Production	Status
	(tonnes/year)	
Copper Cliff South	11 300	core mine
Copper Cliff North	8 100	core mine
Creighton	16 700	core mine
McCreedy East Phase I	9 000	core mine
Subtotal, core - production rate	45 100	
Garson	7 200	marginal mine
Stobie	15 800	marginal mine
Subtotal, marginal mines - production rate	23 000	
Coleman	7 200	to close in 2001
Crean Hill	4 500	to close in 2000
Little Stobie	2 700	to close in 1999
Frood	3 600	to close in 1999
Levack/McCreedy West	3 600	to close in 1999
Shebandowan	5 400	closed in 1998
Whistle	4 000	closed in 1997
Subtotal, mines to be shut - production rate	31 000	
Total production rate	99 100	

Source: Inco Limited *Investor Fact Book*, p. 28, November 1998.
Note: The production rate was given in the source as millions of pounds per year. This was converted to tonnes per year and rounded to the nearest 100 t/y.

TABLE 11. INTERNATIONAL NICKEL STUDY GROUP PUBLICATIONS

World Nickel Statistics - Monthly Bulletin (annual special issue in November contains annual statistics for preceding years)

- Readers can purchase yearly subscriptions to the Monthly Bulletin, or purchase single copies. The November special issue costs more than the Monthly Bulletin for other months.

World Directory of Nickel Production Facilities - June 1996

- The Directory is to be updated and will be published during 1999. The purchase price will include annual updates until the next Directory is published.

To purchase these reports contact:

International Nickel Study Group
Scheveningseweg 62
2517 KX The Hague
The Netherlands

Tel.: 31-70-354-3326
Fax: 31-70-358-4612
E-mail: INSG@compuserve.com

Notes: As of January 1999, prices for single issues of the Monthly Bulletin were in the range of $75 and a yearly subscription was in the range of $600, depending upon the title. Additional information will likely be available from the web site at http://www.insg.org once it is operational.

Potash

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The term "potash" refers to a group of potassium-bearing minerals and chemicals. Potash includes potassium chloride (sylvite), potassium-magnesium chloride (carnallite), potassium sulphate, potassium-magnesium sulphate (langbeinite), and potassium nitrate. The dominant potash product in the market is potassium chloride, or KCl, a naturally occurring pink, salty mineral for which Canada is the leading world producer and exporter.

The main use of potash is in the agricultural sector where it is used as a plant nutrient for its potassium content, which is the third major nutrient after nitrogen and phosphate. Potash plays an important role in the regulation of plant physiological functions; it supports plant growth and primarily enhances the efficiency of plants in the uptake of other nutrients, boosting their nitrogen and phosphate absorption. Industrial potash is used in the manufacture of potassium-bearing chemicals, as an alternative to de-icing salt, and as a water conditioner. Other end uses include detergents, ceramics, chemicals and pharmaceuticals.

World Overview

The world's potash supply/demand situation in 1998 was relatively balanced despite the prevalent financial crisis in Asia and the emergence of currency fluctuations in Latin America. Market conditions in 1998 were driven by a relative stable demand and suppliers reacted by adjusting production and sales, which led to an increase in inventories during the second half of 1998.

World Potash Sales

Global potash sales declined to 24.8 Mt K_2O,[1] along with a contraction in trade from the record level of 1997 due to strong deliveries at the end of 1997 to major importing countries and an expected reduction in imports in Southeast Asia due to a lagging economic and financial crisis in 1998.

Despite the record 1997/98 world crop production, global grain inventories remain below the 18% stock-to-use ratio, which the Food and Agriculture Organization of the United Nations considers the minimum necessary to safeguard world food security. The global fertilizer sector was affected by depressed grain prices and low farm incomes in addition to economic weakness in most emerging markets. However, contrary to other mineral fertilizers, potash demand and prices remained firm in most offshore markets. Sustained demand in key markets such as Europe, China, India and Brazil offset reduced imports in other nations. The economic crisis that has been affecting Asia since 1997 had only marginal effect on potash sales in this region. World potash trade in 1998 declined to 19.4 Mt K_2O, a 1.2-Mt decrease of which Canada contributed 85%. Offshore trade, accounting for 45% of total sales in 1998, was down only 3% from the record 1997 level.

World potash fertilizer sales in 1998 were estimated at 22.6 Mt K_2O. Potash consumption in Asia, which accounted for 30% of world potash consumption, rose marginally. Strong sales to China and India offset lower sales in other countries in Southeast Asia, notably Japan, South Korea and Indonesia, due to the effect of the economic crisis that continued to prevail during 1998. Potash imports in China registered some increase over 1997; however, despite improving potash application, the nitrogen-to-potash ratio continued to remain deficient. Potash sales in India showed a sustained increase from the 1997 level, supported by a higher subsidy level for potash fertilizers,

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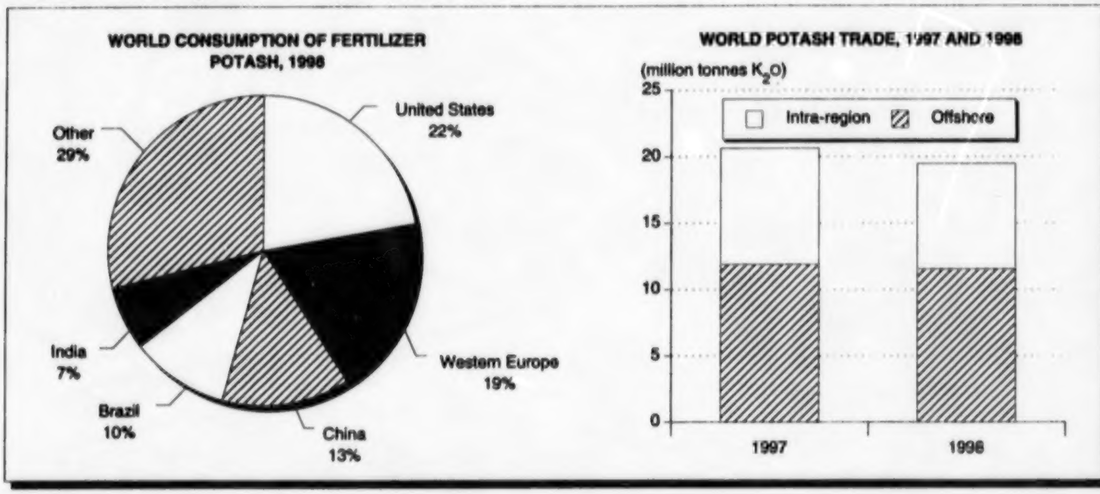
[1] Unless noted otherwise, statistical data refer to potassium oxide (1t KCl = 0.6t K_2O).

Figure 1
Potash Consumption and Trade



Source: Natural Resources Canada.

which rose by 50% to 3000 rupees per tonne of KCl (US$71/t). Increased sales were registered in Malaysia and in the important emerging markets of Thailand and Vietnam.

Potash sales in Europe, which accounted for 18% of world potash consumption, were flat in 1998, but overall consumption is expected to continue to decline gradually as a result of lower crop prices and increased set-aside for 1999. In Central Europe, several countries continued to reform their agricultural program. Poland has been leading in terms of revitalizing its agriculture, along with other countries such as the Czech Republic and Hungary, where potash consumption has been growing steadily. The severe economic conditions in the C.I.S. hampered the agricultural sector and resulted in low grain production in 1998/99; potash use in the C.I.S. remained stable in 1998 after three successive years of increases.

Potash consumption in Latin America, which accounted for 14% of world consumption, remained firm in 1998. In Brazil, potash demand was sustained during most of the year, but financial and economic conditions deteriorated late in the year, leading to strict credit restrictions and a devaluation of its currency. Overall Latin American potash sales were marginally lower than in 1997, but remained at a relatively high level due to strong export prices for cash crop products and commodities early in 1998. In North America, which accounted for 24% of world consumption, potash sales declined 10% in response to relatively low grain prices. In the United States the corn crop in 1998 was a bumper year; despite high domestic demand and strong exports due to lack of competition, production exceeded sales and resulted in inventory additions, helping to raise the stock-to-use ratio above the critical 14% level for the first time in the last three years. Fall sales for potash were weak in North America as the low domestic demand for grain was exacerbated by slow offshore sales.

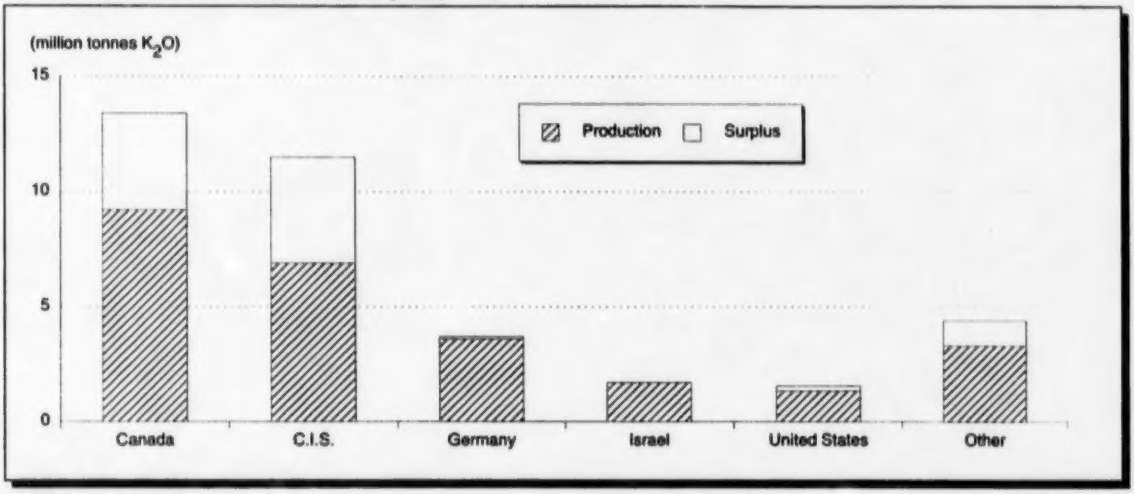
World Potash Production

World potash production in 1998 was estimated at 25.9 Mt K_2O, a 1.5% increase compared to the previous year. Production increases were recorded in almost all major exporting countries with the exception of France, Spain and the United States. The C.I.S. and Germany accounted for 50% of the increase. Globally, potash producers operated at an overall capacity rate of 71% in 1998 compared to 69% in 1997.

Canadian operations ran at 69% of capacity and those in the C.I.S. ran at 58%, while all other major world producers operated at levels above 80%, with the exception of France (58%) and Spain (72%). In 1998, potash suppliers increased production in anticipation of firmer sales during the last quarter of the year, resulting in a significant 1.2-Mt K_2O increase in inventories reported in Canada and the C.I.S.

World capacity decreased marginally to 36.2 Mt/y K_2O as closures and reductions in Spain, France and the United States were not offset by expansions in

Figure 2
World Potash Production and Surplus, 1998



Source: Natural Resources Canada.

Chile and Israel. Natural Resources Canada estimates that the world's potash production capability declined to 29.9 Mt/y K_2O in 1998 from 31 Mt/y in 1997; the reduction is mostly accounted for by the flooding of the Potacan mine in the fall of 1997. The global surplus of capacity over production in 1998 was estimated at 10 Mt K_2O, of which Canada and the C.I.S. contributed 90%.

CANADIAN INDUSTRY

By year-end 1998, the potash industry in Canada was comprised of three companies that together employ more than 3400 workers. Production occurred at eight underground mines and two solution mining operations in Saskatchewan, and at one underground mine in New Brunswick. Another operation in New Brunswick only used the compaction facilities after its underground mine flooded in 1997. The Canadian potash industry was first developed in the early 1960s with the opening of potassium chloride mines in Saskatchewan. As the result of a series of expansions in the 1970s and 1980s, Canada now ranks as the world's largest producer and exporter of potash.

Major Developments

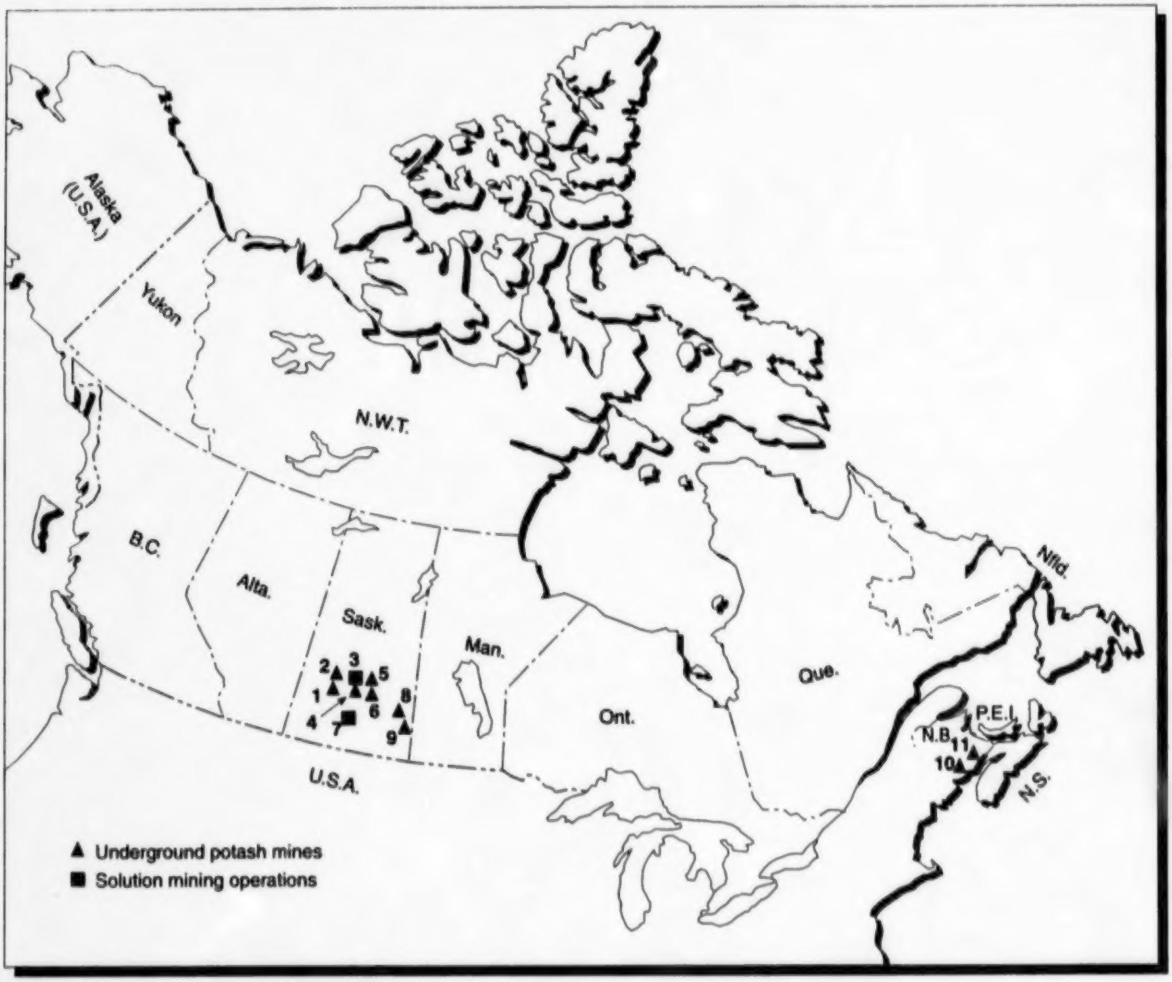
In 1998, Canadian potash production increased by 2% to 15 Mt KCl. Canadian potash shipments declined by 4% to 13.5 Mt KCl, a reduction mostly caused by weaker sales to U.S. markets. Canada's value of total potash sales (f.o.b. mines) was estimated at $1.7 billion in 1998, compared to $1.5 billion in 1997. Canadian inventories increased by 1.1 Mt to 2.6 Mt KCl.

Canada is the world's largest potash exporter with a 44% share of international trade. The C.I.S. is the second largest exporter, followed by Germany. Canada exports potash to more than 40 countries, although only six countries account for close to 80% of Canada's total potash exports. In 1998, Canadian potash was shipped mostly to the United States (60%) and Asia (25%), with the remainder being sent to Latin America (10%), Oceania (3%) and Europe (2%).

Canadian potash exports to almost every region decreased in 1998. Data compiled by Statistics Canada indicated that Canadian potash exports were valued at $2 billion. The United States was the dominant destination for Canadian potash; in 1998, sales to the U.S. declined by 20%. In offshore markets, sales decreased by 5%. Sales to China remained stable; this country still accounted for 30% of all offshore potash exports from Canada. Shipments to Latin America decreased by 11% in 1998; Brazil, which accounted for 78% of Canadian sales in this region, registered a minor decrease, along with Cuba, Guatemala and Honduras. Sales to Europe dropped by 10% due to lower shipments to France and Belgium. Exports to Oceania declined 8% as lower sales to New Zealand were not offset by increases to Australia.

The major events in the Canadian potash industry during 1998 included the purchase of Potacan Mining Company of New Brunswick by Potash Corporation of Saskatchewan, the emergence of water inflows in the underground potash mine at PCS New Brunswick Division, and the continuation of incremental

Figure 3
Location of Potash Mines and Operations in Canada, 1998



Numbers refer to locations on map above.

UNDERGROUND POTASH MINES

1. Agrium Inc., Vanscoy, Saskatchewan
2. Potash Corporation of Saskatchewan Inc., Cory Division, Saskatoon, Saskatchewan
4. Potash Corporation of Saskatchewan Inc., Allan Division, Allan, Saskatchewan
5. IMC Central Canada Potash Inc., Colonsay, Saskatchewan (IMC Kalium)
6. Potash Corporation of Saskatchewan Inc., Lanigan Division, Lanigan, Saskatchewan
8. International Minerals & Chemical Corporation (Canada) Global Limited (K1 and K2 mines), Esterhazy, Saskatchewan (IMC Kalium)
9. Potash Corporation of Saskatchewan Inc., Rocanville Division, Rocanville, Saskatchewan
10. Potash Corporation of Saskatchewan Inc., Cassidy Lake Division, Clover Hill, New Brunswick (milling facilities only)
11. Potash Corporation of Saskatchewan Inc., New Brunswick Division, Sussex, New Brunswick

SOLUTION MINING OPERATIONS

3. Potash Corporation of Saskatchewan Inc., Patience Lake Division, Patience Lake, Saskatchewan
7. IMC Kalium Canada Limited, Belle-Plaine, Saskatchewan (IMC Kalium)

expansions in some Saskatchewan potash operations. In 1998, Canada's annual potash capacity was estimated at 13.4 Mt K_2O, of which about 1.5 Mt consisted of idle milling units at the Cory, Lanigan and Patience Lake operations in Saskatchewan. Considering that capacity figures are based on milling, Canada's potash capability was estimated at 10.5 Mt K_2O (17.2 Mt KCl).

Saskatchewan

Saskatchewan produced about 95% of total Canadian output in 1998. During the year, several temporary shut-downs were carried out by mine operators in the province for inventory control and, to a lesser extent, for maintenance and vacation. The potash industry of Saskatchewan ranks as the world's most productive. Its productivity is more than 10 times that of the Russian industry, and three times more than that of the European potash producers. The Saskatchewan potash industry accounts for 33% of world production and 33% of world capacity.

In early 1998, the Province of Saskatchewan announced a series of measures in its tax regime for potash: the elimination of the top profit tax bracket of 50% (leaving 35% as the top rate); an expansion of the 15% profit tax bracket by 2001; the freezing of the base payment rate at the 1997 level; and a 35% depreciation rate applicable to all capital investment.

Potash Corporation of Saskatchewan Inc. (PCS), based in Saskatoon, is the largest publicly held potash producer in the world, holding 23% of the world's potash capacity. PCS operates five mines in Saskatchewan, one underground mine/mill operation in Sussex, and another mill close to Sussex in New Brunswick. PCS also owns reserves at Esterhazy that are mined by International Minerals & Chemical Corporation (Canada) Global Limited (IMC Kalium) under a long-term agreement that entitles PCS to 25% of production. All PCS mines, except the Patience Lake solution mine, use conventional underground mining techniques. In 1998, potash production from all of PCS's operations, including tonnage from the New Brunswick Division and from PCS's account at Esterhazy, was estimated at 6.9 Mt KCl, an 8% increase compared to 1997; PCS's operating rate was 52%. Throughout 1998, PCS continued to pursue its policy of strict inventory control with intermittent shut-downs at all of its operations. PCS's production milling capacity is estimated at 13.4 Mt KCl (or 8.2 Mt/y K_2O), equating to 62% of Canada's total potash capacity. During 1998, PCS purchased a 9.03% stake in Israel Chemicals Ltd., but failed to acquire the assets of Grupo Potasas, which was sold by the Spanish government during the summer of 1998. PCS also contemplated the possible acquisition of the 53.3% interest in Israel Corp. held by the Eisenberg family (Israel Corp. holds a 52% interest in Israel Chemicals Ltd., which owns Dead Sea Works Ltd.).

IMC Kalium, a division of IMC Global Inc., manages four potash operations in Canada: the two interconnected underground mines, K1 and K2, at Esterhazy in southeastern Saskatchewan; one large potash solution mine at Belle-Plaine, west of Regina; and a conventional underground mine located at Viscount/Colonsay in the Saskatoon area. Altogether, IMC Kalium's Canadian potash capacity is estimated at 6.5 Mt KCl (or 4 Mt/y K_2O), or 30% of Canada's total potash capacity (and 12% of the world's). In 1998, IMC Kalium's production was estimated at 5.3 Mt KCl and its overall operating rate was 82%. During 1998, the company continued its important structural consolidation program at the Esterhazy mines in Saskatchewan to reduce water inflows that have been occurring for the past ten years with the objective of cutting the inflow rate to its minimum by 2000. IMC Kalium pursued its expansion program at Belle-Plaine and, late in 1998, decided to postpone the expansion at Colonsay due to the current global oversupply. IMC Global purchased the assets of Harris Chemical Group and became one of the largest salt operators in Canada.

Agrium Inc., based in Calgary, holds 8% of Canada's potash capacity (3% of the world's) and operates one mine in Vanscoy, Saskatchewan, with a capacity estimated at 1.8 Mt KCl (or 1.1 Mt/y K_2O). In 1998, Agrium Inc. produced close to1.6 Mt KCl and operated at 89% of capacity (80% in 1997). During 1998, Agrium pursued the construction of a new phosphate mine at Kapuskasing in northern Ontario. The operation will be commissioned in the fall of 1999 and the $75 million project will create 100 permanent jobs. Phosphate concentrates will be sent to Agrium's fertilizer facilities in Redwater, Alberta, to replace imported phosphate rock from Togo.

Big Quill Resources Inc. manufactured potassium sulphate from sodium sulphate brine at Big Quill Lake and from purchased potassium chloride. The company, located in Wynyard, expanded its production capacity to 60 000 t/y of secondary potassium sulphate (K_2SO_4). The company operated an ion exchange 10 000-t/y unit and commissioned a 50 000-t/y unit using the glaserite process. Big Quill indicated plans for a potential expansion to 300 000 t/y in the future. Potassium sulphate products are used in the fertilizer, chemical and wallboard sectors.

New Brunswick

In New Brunswick, potash was mined at one underground operation located in the Sussex area of Kings County. Another operation, Potacan Mining Company, which was located 20 km southeast of Sussex, was flooded late in 1997 after operating for 12 years. Potash products for export are hauled 60-80 km from the Sussex area to the Barrack Point potash terminal in Saint John. The terminal has a storage capacity of

165 000 t of potash. The shipping port, equipped with a 2700-t/h ship-loading facility, can accommodate cargo sizes between 3000 and 50 000 t.

The New Brunswick Division of PCS operated the Penobsquis underground mine about 5 km east of Sussex. The operation experienced minor water inflows in its underground mine; however, the water condition did not affect mining operations. The company registered a record production level in 1998 of more than 780 000 t KCl, exceeding its estimated capability and quoted capacity. The mine continued to operate throughout the year at high capacity utilization. Mining is carried out by cut-and-fill methods, along with the use of a room-and-pillar layout. Salt tailings, slimes and excess brine are stored underground as part of an integrated closed-loop mining system. PCS may, in the near future, investigate the possibility of expanding its mining operation at the PCS New Brunswick Division in Sussex.

In early 1998, PCS completed the purchase of Potacan's assets from its European owners, renaming the operation as PCS Cassidy Lake Division. The processing mill was used to upgrade standard-grade products from Saskatchewan into granular products for markets in eastern Canada and the United States.

Manitoba

Late in 1998, both parties involved in the Manitoba Potash Corporation, a joint venture between Entreprise minière et chimique of France and the Government of Manitoba, expressed an intention to assess different options regarding their respective share in the project. The joint venture holds the rights to a sylvinite deposit in the Russell-Binscarth area adjacent to the Manitoba-Saskatchewan border. Proven mineable ore reserves were estimated at 120 Mt of potash grading 24.5% K_2O. Initial development plans in the 1980s called for a 2-Mt/y potassium chloride mine.

International Developments

In 1998, world production of potash rose to meet a sustained demand and refurnish the prevailing low inventories at year-end 1997. World production increased by 1.5% to 25.9 Mt K_2O. Most of the 0.5-Mt increase occurred in the C.I.S. (45%) and Canada (30%). North America was the major producing region with a 40% share of world potash output; Canada contributed 35% to world production in 1998, followed by the C.I.S. (27% share), Western Europe (20%) and the Middle East (10%).

The Americas

In Brazil, potash production by Companhia Vale do Rio Doce increased by 19% over 1997. Capacity is expected to increase to 700 000 t/y of potassium chloride by 2000, in combination with a 100 000-t/y compaction capacity for the production of granular potash products.

In Chile, potash production rose by 6% over 1997. SQM Salar S.A., a subsidiary of Sociedad Quimica y Minera de Chile S.A., completed the second phase of its Minsal project at Salar de Atacama that included a new 250 000-t/y potassium sulphate plant. Another expansion of its current potassium chloride capacity is being envisioned. SQM and Norsk Hydro entered into an agreement for the construction of a new 150 000-t/y potassium nitrate operation in northern Chile; the project will be completed after 2000. Minera Yolanda S.A., a subsidiary of Kap Resources Ltd. of Vancouver, continued to face technical and financial difficulties at its 250 000-t/y potassium nitrate facility at Yumbes in northern Chile. Atacama Minerals Corporation, a subsidiary of Boron Chemicals International Ltd. of Vancouver, indicated that its development plans at Aguas Blancas in northern Chile will now focus on iodine; a 70 000-t/y potassium nitrate facility might be considered after 2005.

In the United States, potash production declined by 10% in 1998 and the industry operated at 86% of capacity. Late in 1997, Mississippi Chemical Corporation announced the permanent closure of its 300 000-t/y potassium chloride Eddy Potash mine in Carlsbad, New Mexico. In 1998, Mississippi Chemical Corporation announced an expansion at its Mississippi Potash West facility in Carlsbad to reach a capacity of 0.5 Mt/y KCl. Also in 1998, IMC Global concluded the acquisition of the assets of Harris Chemical Group Inc. (HCG), which included the potash operation of Great Salt Lake Minerals Corporation at Ogden, Utah, where capacity was expanded to reach 500 000 t/y of potassium sulphate by year-end 1998. IMC also announced plans for combining sylvinite and langbeinite ore extraction from its Carlsbad operation and from the former Western Ag-Minerals mine, as well as plans to construct a new potassium-magnesium potash processing facility in Carlsbad to be completed in 1999.

C.I.S.

Potash production in the C.I.S. in 1998 increased for the third consecutive year and reached 6.9 Mt K_2O. The annual operating rate was close to 58% of capacity, compared with 56% in 1997. Russia's potash production was stable at 3.5 Mt K_2O with an overall operating rate of 54%; its potash was produced by Uralkali Ltd. and Sylvinit Ltd. In Belarus, potash production rose 10% to 3.5 Mt K_2O; PO Belaruskali operated at 63% of capacity, its highest level for the past six years. C.I.S. potash deliveries totalled 6.6 Mt K_2O due to sustained offshore and domestic sales. Domestic deliveries remained stable at 1.4 Mt K_2O in 1998; Belarus delivered 57% of domestic

sales. A new investment organization has been set up in Russia, InterAgroInvest, which is a joint venture of multiple interests, including IPC and the potash producers in the C.I.S. The group was set up to secure investment in the domestic potash production, transportation and distribution sectors. In mid-1998, Uralkali commissioned a new secondary potassium sulphate facility at Berezniki 3; its feedstock is pink potassium chloride from the same potash plant. Its annual capacity is estimated at 120 000 t/y K_2SO_4 (60 000 t/y K_2O).

Total C.I.S. exports increased by 3% to 5.2 Mt K_2O in 1998. Exports rose in most regions with the exception of Latin America. Major export destinations were China (1.3 Mt K_2O), followed by Brazil (0.6 Mt), Central Europe (0.6 Mt), India (0.7 Mt) and the United States (0.3 Mt). Exports were shipped mostly from the Port of Ventspils (Latvia), and partly from the Russian Port of St. Petersburg, the Ukrainian ports of Ilyichevsk and Nikolaev on the Black Sea, and the Port of Klaipeda (Lithuania). An important level of shipments are also moved by rail to the Far East Port of Vostochny for delivery in Southeast Asia. Several terminal facilities are being expanded at numerous ports within the C.I.S. and in the Baltics (Klaipeda, Ventspils, Murmansk, Ust Luga, and St. Petersburg). In 1998, JSC Kalija Parks in Latvia inaugurated a new storage facility at its potash terminal in the port of Ventspils. Total new storage was expanded by 40 000 t and raised the terminal's potash handling capacity to 5.5 Mt/y KCl. A new berth, which will be equipped with a 3000-t/h ship loader, is scheduled for completion in 1999. Additional projects for increasing the handling volume at the terminal are planned to bring it to a capacity of 6.5 Mt/y of products in the medium term.

Europe

In early 1998, the European Commission completed its three-year administrative review of existing anti-dumping measures against C.I.S. potash-producing countries and implemented a 7% decrease on the minimum import prices while maintaining fixed duties for each producing country. In March 1999, the Commission initiated a full review of the anti-dumping measures applicable to imports of potassium chloride originating in Belarus, Russia and Ukraine. Late in 1998, the European Association of Potash Producers filed a request for review following a notice of impending expiry of the measures.

In France, potash production continued to decrease for the sixth consecutive year as a result of the phase-out of potash mining in Alsace. Its 1998 production declined by over 35%. According to the Société Commerciale des Potasses et de l'Azote, the two remaining French mines are forecast to close between 2002 and 2004, and production is expected to decline gradually. Mines de Potasse d'Alsace (MDPA) closed one of its three operating mines in early 1998; the Marie-Louise Est mine and its three operating shafts (Marie-Louise, Marie and Schoenensteinbach) at Staffelfelden closed after 85 years of operation due to ore exhaustion. The two remaining operating shafts, Berwiller at Marie-Louise Ouest and Amélie 1 at Amélie, will close in 2002 and 2004, respectively. The crystallization units at Marie-Louise will be shut down in 1999 and all potash ore will be processed at the remaining flotation plant at Amélie.

In Germany, potash production rose marginally. In 1998, BASF continued to sell its shares in K&S Beiteiligungs AG (K&S) to private investors; as a result, BASF has reduced its shareholding to less than 25%. K&S is now the sole owner of the operating German potash company following its purchase of the 49% share of Kali und Salz GmbH from Beiteiligungs-Management Gesellschaft mbH, the state agency for the privatization of the former East German industry. In 1998, K&S continued its development work in Hessia with the goal of merging the underground operations of Hattorf and Wintershall.

In Spain, potash production declined by 22% as a result of the completion of the closure of Potasas de Subiza's mine in Navarra. Potash is now extracted from two mines at Llobregat and Suria in Catalonia. In 1998, the Spanish government privatized the potash mining group, Grupo Potasas, which comprises Potasas de Llobregat, Suria K, Commercial de Potasas, Societé Générale des Sels et Potasses, and Trafico de Mercancias. Dead Sea Works Ltd. (DSW) of Israel and two Spanish companies purchased Grupo Potasas for US$123 million; the company is now operating under the name of Iberpotash. Later in 1998, DSW announced plans to increase current Spanish potash output over the next five years.

In the United Kingdom, Cleveland Potash Ltd.'s (CPL) production rose 8% over 1997. In early 1999, CPL's underground potash mine at Boulby in northeastern England was being affected by water inflows that occurred in a conveyor roadway leading to a production stope in the southern part of the mine. The company indicated that potash production will be significantly reduced during the first half of 1999 as potash ore will only be extracted from stopes in the northern part of the mine. This underground operation is among the deepest in the world at 1100 m, and feeds a 1.1-Mt/y KCl potash milling facility. CPL is reported to have plans for expanding its production of granular potash products.

Middle East

In Israel, DSW's production rose 13% in 1998. The company continued to remove salt pillars from the solar evaporation ponds for improving its overall carnallite recovery. DSW announced a US$90 million plan to expand its potash operation at Sdom, including new equipment for industrial-grade potash products and compaction units for granular potash

grades. Total capacity is expected to reach 2.8 Mt/y KCl by 2000. Israel Chemicals, which was founded by the Israeli government, has been gradually privatized since 1992; late in 1998, the government sold its remaining 31.5% interest in a public offering. Haifa Chemicals Ltd. was reported to invest US$45 million for a 100 000-t/y potassium nitrate expansion at its Mishor Rotem facility by 1999.

In Jordan, potash production by the Arab Potash Co. Ltd. (APC) increased by 14% and the operation ran at 85% of capacity. APC continued to work on its expansion program at Safi to increase capacity by 20% to 2.2 Mt/y KCl of potassium chloride in 2002; a second phase is also being contemplated for another 200 000 t/y KCl by 2004. Jordan Dead Sea Industries Company, in which APC has a 51% controlling interest, signed an agreement with Ching Hsiang Chemicals of Taiwan to construct a new 40 000-t/y potassium sulphate plant in Aqaba to be completed in 2001; 75% of its production will be dedicated for exports. APC and Kemira Agro of Finland announced a new joint venture to construct a US$70 million potassium nitrate plant in Safi; the 150 000-t/y KNO_3 facility is scheduled for completion in 2001.

Asia

In China, potash production was estimated at 170 000 t K_2O. In 1998, the specialized press reported progress in the joint venture involving Dead Sea Works and the Eisenberg Group of Companies of Israel; a memorandum of understanding was signed to settled the financial aspects after nine years of discussions. The project calls for the construction of an 860 000-t/y potash mine to be developed at Qarhan Salt Lake in the northwestern Qinghai Province. The mine is expected to be commissioned in 2004. Partners in the project include the United Development Industry Co. of Israel, Mingda Corporation, and the Qinghai Salt Lake Industrial Group of China.

In northeastern Thailand, the ASEAN Potash Mining Co. (APMC) continued its construction work to develop a salt-potash mine at Bamnet Narong. The US$590 million project is for an underground mine with a capacity of about 1 Mt/y of potassium chloride. The construction of a 935-m-long decline to the 180-m level was completed at the end of 1997. In 1998, APMC contracted work for construction of the second decline drift into the carnallite orebody and started development work on the first salt stope from which were extracted 50 000 t of salt and 50 000 t of carnallite grading 12% K_2O. APMC plans to award engineering design contracts in early 1999 and to assess options for the disposal of sub-product magnesium brines, including through deep-well injection. APMC expects to produce 0.5 Mt/y of salt and to start potash mining by 2003.

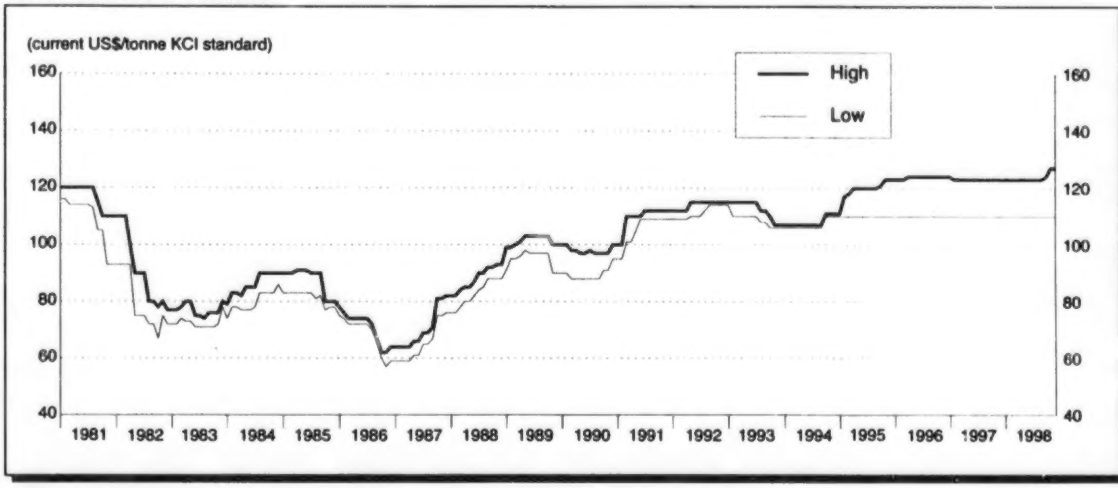
Also in northern Thailand, Asia Pacific Potash Corporation (APPC) completed a bankable feasibility study in 1998 for the development of a sylvinite potash deposit in the Sakon Nakhon Basin close to the Laos border. The company has been investigating two orebodies: the Somboon and Udon fields. The development of the first 2-Mt/y potassium chloride mine is currently centred around Somboon where mineable reserves have been estimated at 180 Mt of sylvinite ore grading 23% K_2O. Access to the mine will be by twin declines to a depth of 350 m. Ten continuous mining machines will extract close to 6 Mt/y of ore using a chevron room and pillar technique. In 1998, Asia Pacific Resources Ltd. of Vancouver (APR) acquired the holding interest of Metro Resources Ltd. in APPC. The transaction increased APR's effective interest in APPC from 62.5% to 90%; the remaining 10% interest is held by the Government of Thailand. In mid-year, APR and Norsk Hydro Asia Pte. Ltd., a subsidiary of Norsk Hydro ASA of Norway, signed a Memorandum of Understanding for the financing and development of the Udon Thani potash resources. Norsk Hydro would become an equity participant in APPC and market all the potash produced from the Somboon mine. A decision to start construction is expected in 2000 for completion in 2004. The total cost of the project, which is expected to employ 1400 workers, has been estimated at US$500 million.

PRICES

The price of potash quoted on a free on board (f.o.b.) Vancouver basis (in U.S. dollars) is considered to be the pricing indicator for most Canadian international offshore sales. In many markets, prices are also quoted on a delivered basis, CFR (cost and freight) and c.i.f. (cost, insurance and freight) foreign ports. Canpotex Limited, representing all Saskatchewan potash producers, sells both f.o.b. Vancouver or c.i.f. foreign ports, or out of warehouses in Asia.

Offshore potash price quotations were firm in 1998, registering a slight increase by year-end 1998 and early 1999. For 1998, price quotations rose by 2% to an average of US$118.50/t standard KCl f.o.b. Vancouver. Entering 1997, f.o.b. Vancouver potash prices were quoted averaging US$116.50/t KCl for standard grade. During the first half of the year, sales to China provided an upward momentum to world offshore trade and prices. However, a price increase achieved in China did not translate into subsequent increases in other offshore contracts. The international market continued to firm up in the first half of 1998 following a price increase in Japan. In the beginning of the second half of 1998, potash markets remained firm with sustained prices. Many exporters sought a second price increase, which ultimately did not materialize due to a slowdown in trade and the residual effect of the economic crisis affecting Asia and spreading to Brazil. By the end of

Figure 4
Canada, Offshore Potash Price Quotations, 1981-98
f.o.b. Vancouver Contract



Source: Compiled by Natural Resources Canada from trade magazines and specialized subscriptions.

the year, price quotations were relatively steady at an average of US$118.50/t. With favourable market perspectives for 1999, price quotations were moving upward in the first quarter of the year. In other offshore business, C.I.S. potash prices were quoted at US$85-$90/t for standard potash f.o.b. Baltic ports in 1998, and remained at that level until the third quarter. By year-end, the price had risen to reach US$95-$105/t for an average 15% increase for the entire year.

In North America, quotations f.o.b. Midwest on coarse-grade potash started at US$114-$120/short ton (st) in January 1998. Despite some tardiness in spring planting due to early rain, overall demand was sustained and supply was tight, a combination that led to another price increase in the spring of 1998 to US$119-$123/st. During the second half, after a seasonal correction during the summer, quotations rose to reach US$120-$124/st. Domestic demand has slowed with a weak fall season due to lower expectations for 1999 and successive price increases. On average, potash prices in the United States increased 20% over 1997. The gap between low and high quotations tended to increase by year-end, signalling some stability in the first quarter of 1999.

OUTLOOK

Despite the record 1997/98 world crop, the global grain stocks-to-use ratio rose marginally from 16% to 18%, a level that is still considered to be near the minimum for world food security. Low grain prices in 1998 have resulted in a recovery in world domestic and offshore sales, yet have also moved prices upward in 1999. Improvements for fertilizer demand are projected by 2000 as fundamental agricultural needs support a sustained demand for fertilizers to increase food production and quality in a global environment where the supply of arable land is declining. The economic and welfare growth in developing nations will continue to generate a demand for improved agricultural products to meet the needs of a growing population looking for an enhanced high-protein diet; this will be achieved through better farming practices, new hybrid crops, and improved, balanced fertilization.

World Potash Demand

In the European Union, long-term demand for fertilizer is forecast to decline due to improved land management and more efficient fertilizer usage. Important socio-economic changes are expected over the next 10 years as the European Union becomes larger. The Common Agricultural Policy outlined in the "Agenda 2000" is expected to result in a reduction in the use of fertilizers and an improvement in farming practices. Acreage set-aside beyond 2000 is foreseen at 0%, although voluntary set-aside is expected to continue. By 2007, potash nutrient consumption is projected to reach 3.9 Mt K_2O, a 7% decline over the next 10 years.

In Central Europe, increased fertilizer use is expected to accompany significant agricultural development and the rebuilding of soil fertility in several countries, including Poland and Hungary.

In the C.I.S., agricultural development continues to be closely linked to land access and ownership, availability of credits, and government support for reforms. Farming in most republics is predominantly carried out in former state and collective farms. Over the next 10 years, potash consumption is forecast to recover, albeit not at the level that prevailed prior to 1988 when fertilizer application was dictated by central agencies. By 2007, potash demand could reach 2.4 Mt K_2O, doubling the 1998 level (but one third of the record level set in 1988).

Potash application in the United States in 1999 is projected to be marginally lower than in 1998 as the result of lower acreage for corn and wheat. In 1999, a US$5.9 billion disaster relief support was approved to provide farmers with income supplement. In the medium to long term, potash demand is forecast to be stable, with some anticipated increase in the near term (2000-02). The *Freedom to Farm Act* has allowed farmers to better respond to market conditions. Fertilizer potash demand is forecast to reach 5.3 Mt/y by 2007.

Sales to Brazil are projected to be stable as credit and currency pressures are alleviated. Brazil offers much potential for agricultural land and crop diversity; its agriculture is highly geared toward export cash crops such as coffee, sugar cane, soybeans and fruits, rather than mainstay crops, which results in a distinctively favourable nitrogen-to-potash nutrient ratio of 1:1.65 (compared to North America at 1:0.44), and which explains the high level of potash consumption. In the long term, there are opportunities to increase potash use by improving the potassium application rate in basic food crops such as corn, and the nitrogen application rate in certain cash crops. An increase in the application of nitrogen to the recommended level could result in additional total potash demand of close to 1.2 Mt K_2O. With current potash consumption at around 2.1 Mt, the potential demand could reach 3.3 Mt/y by 2007.

Potash demand in India is projected to remain stable in 1999. In the short term, fiscal and regulatory measures that are being introduced by the Government of India will affect the current subsidized and expensive domestic market structure. In early 1999, India imposed a 5.5% import duty on fertilizers that previously were exempt from such levies. During 1999, the Government of India is expected to revisit its current subsidy scheme and to liberalize the minimum retail price structure for fertilizers. In the long term, potash demand in India has the potential to increase by 50% between 1998 and 2007, and to reach 2.2 Mt/y to meet its need for improving crop yields and correcting the resilient nutrient imbalance in the nitrogen-to-potash ratio (1:0.12 compared to a potential of 1:0.18; the optimal ratio is reported at 1:0.25).

In China, positive economic growth continues in accordance with its current Five-Year Economic Plan that focusses on developing its agricultural sector by raising grain production, improving farming practices, and facilitating access to domestic fertilizers. The imbalance in the reported nitrogen-to-potash ratio (at 1:0.10) remains below the optimum target (1:0.20); Chinese potash consumption would need to double in order to meet its optimal agronomic nitrogen-to-potash ratio, leading to a potential for imports at close to 5 Mt/y K_2O by 2007.

Total world demand for potash in 1999 is projected at 26 Mt K_2O, including 23.4 Mt K_2O for fertilizer potash (a 3% increase over 1998), 1.6 Mt K_2O for industrial uses, and around 1.0 Mt K_2O as a distribution gap. Most of the increase in demand during 1999 will be registered in Asia, while potash fertilizer consumption is expected to continue to recover in Europe, the C.I.S. and Latin America.

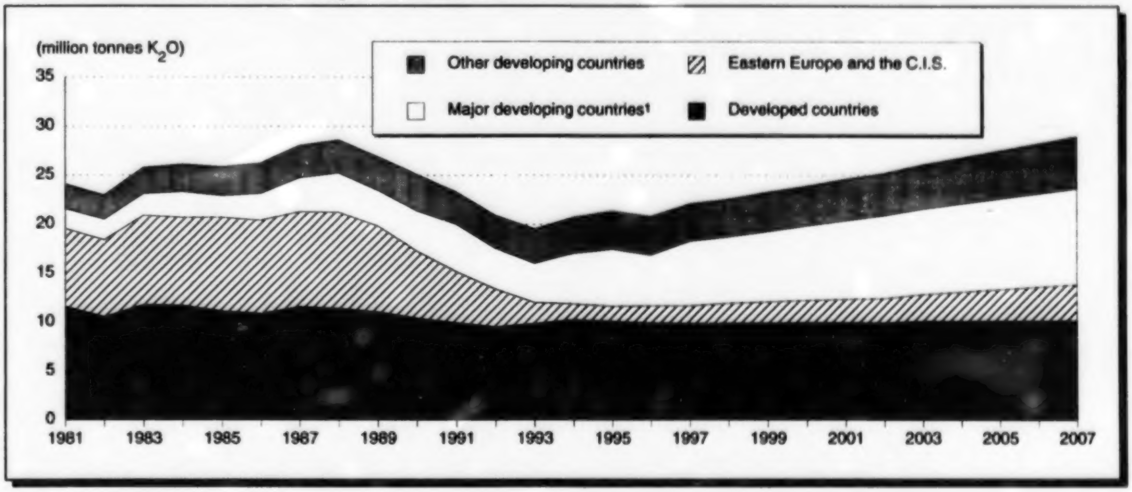
Long-Term Potash Demand

In the long term, world potash demand is expected to continue to expand, following a trend that has emerged since 1993. Fertilizer potash demand for the period 1997-2007 is forecast to grow by an overall 30%, or at an annual rate of 3% to reach 29 Mt/y by 2007. Most of the 7-Mt/y increase in this 10-year period will be registered in Asia (50%), followed by the Americas (25%) and the C.I.S. and Central Europe (25%). World demand for industrial potash is projected at 2 Mt/y K_2O by 2007. Taking into account growing industrial uses and fertilizer consumption, as well as the distribution gap, total world demand for potash is forecast at close to 32 Mt/y K_2O by 2007, compared to 24.5 Mt in 1997. Growth in developed countries will be marginal, while Central Europe and the C.I.S. are expected to register a sustained recovery, accounting for 13% of world fertilizer potash demand in 2007 compared to 8% in 1997. Most of the growth in potash consumption will come from developing countries, which will account for 52% of world demand for fertilizer potash, compared to 47% in 1997.

World Potash Supply

On the supply side, current potash capacity from established producers is expected to increase marginally as incremental expansions offset the anticipated closure of the French mines. The capacity from current producers in 2007 is estimated at around 37 Mt/y, compared to 36.4 Mt/y in 1997. Established producers have been announcing expansions in Canada, the United States, Chile, Brazil, Israel and Jordan for a wide range of potassium products, including potassium chloride, potassium sulphate and potassium nitrate. From their perspective, the

Figure 5
World Potash Demand by Regions, 1981-2007



Source: Natural Resources Canada.

[1] Includes China, Brazil and India.

marginal cost of new capacity has been more favourable than the unit cost associated with the opening of new mines.

For the past six years, the sustained demand for potash in developing countries combined with the prospect of accrued growth over the long term have led several promoters to find adequate economic resources and design plans for new potash operations in favourable locations, i.e., near growing markets. A series of new projects has been scheduled for development in the medium to long term associated with different levels of probability of success and timeliness. Projects in Asia (China and Thailand) have been initially deemed for commissioning in the 1999-2000 period and, if they occur, production would most likely emerge post-2004/05. These projects are estimated to have a medium to high level of probability of occurrence and would add close to 2.4 Mt/y of new capacity by 2005. Other developments are being assessed as more tentative (in Argentina, Congo, Ethiopia, Manitoba and Oman) and would, if realized, add a marginal increase of 1.8 Mt/y K_2O to world capacity after 2005. Between 2000 and 2007, most projects for new mines will be located in potash-consuming and importing regions; these new operations may have the potential to change current trade patterns, which will affect major suppliers to these regions. Established trading countries such as Canada, Germany and the C.I.S. face the possibility of new competition impacting on their market share, unless the commissioning of these new mines are concurrent with an expansion in demand in developing countries. However, producers in Russia, Belarus and Germany are likely to benefit from the phase-out of potash capacity in France by 2004 and the anticipated recovery of potash demand in Central Europe and the C.I.S.

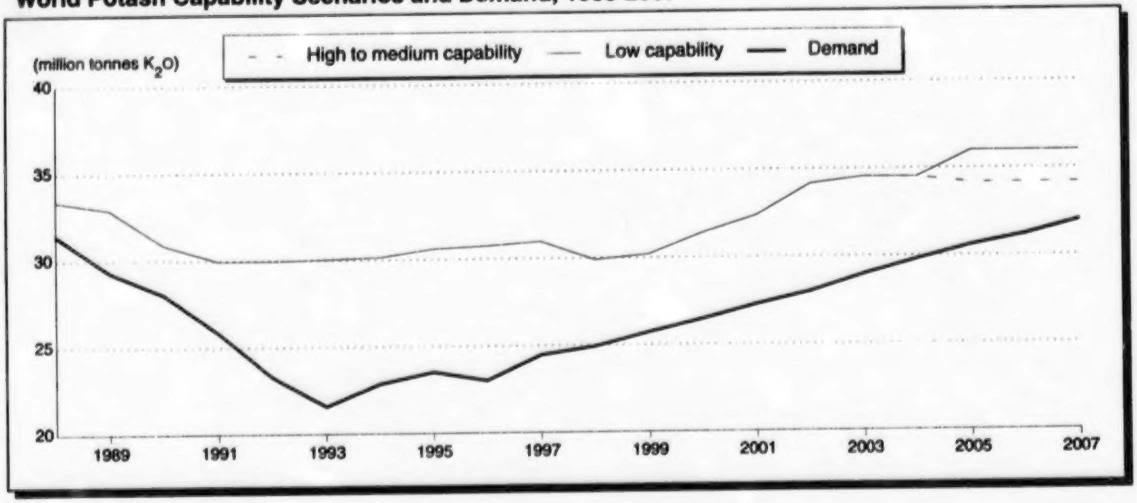
The global potash capacity has the potential to increase by an overall 8% to 41.2 Mt/y in 2007, of which 85% may come from new projects. For the next 10 years, the world's potash supply/demand balance is forecast to face a declining surplus. Based on capacity projections and demand forecasts, this surplus is expected to decline very gradually from 11 Mt K_2O in 1997 to 9 Mt/y by 2007. This surplus will be distributed among several producers, including those in Canada and the C.I.S. New producers in emerging nations will likely enter the marketplace in a period of sustained demand and declining surplus, but will also face competition among themselves for operating at economic, profitable levels.

A better measure of world potash balance is obtained with the concept of capability (which refers to achievable marketable production capacity when considering technical and logistical constraints). World production capability for 1998 was estimated by Natural Resources Canada at around 30 Mt K_2O for a marketable surplus over demand of about 5 Mt K_2O. By 2007, the world's potash capability, including new projects with a medium to high probability of occurrence, is projected at about 34 Mt/y with a marketable surplus of close to 2 Mt/y K_2O. The surplus-to-demand ratio would be reduced from the current 20% level down to less than 7% in 2007. However, if all announced projects were to be commissioned by

2005, the global capacity would have the potential to exceed 41 Mt/y K_2O, with capability estimated at more than 36 Mt/y. The consequent excess of capability in 2007 would be close to 4 Mt, equating to a ratio above 13% and indicating a trend toward a new extended surplus period.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of March 31, 1999.

Figure 6
World Potash Capability Scenarios and Demand, 1988-2007



Source: Natural Resources Canada.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
3104.20	Potassium chloride	Free	Free	Free	Free
3104.30	Potassium sulphate	Free	Free	Free	Free
3104.90.00.10	Magnesium-potassium sulphate	Free	Free	Free	Free
3104.90.00.90	Other	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999.

TABLE 1. CANADA, POTASH PRODUCTION, SHIPMENTS AND TRADE, 1997 AND 1998

Item No.		1997		1998[p]	
		(tonnes)	($000)	(tonnes)	($000)
PRODUCTION, Potassium Chloride					
Gross weight		14 711 940[r]	. .	15 131 432	. .
K_2O equivalent		8 989 417[r]	. .	9 269 978	. .
SHIPMENTS					
K_2O equivalent		9 234 742[r]	1 528 341[r]	8 968 981	1 666 978
IMPORTS, Fertilizer Potash					
3104.20	Potassium chloride, in packages weighing more than 10 kg				
	United States	4 421	586	4 416	608
	France	231	31	402	55
	United Kingdom	44	5	29	5
	Spain	–	–	1	2
	Germany	29	3	4	1
	Switzerland	2	1	2	. . .
	Belgium	124	18	–	–
	Total	4 851	644	4 854	671
3104.30	Potassium sulphate, in packages weighing more than 10 kg				
	United States	5 843	1 886	7 607	2 274
	Russia	–	–	869	988
	Belgium	–	–	231	116
	United Kingdom	2	3	6	6
	Germany	10	22	3	4
	Japan	–	–	2	2
	Canada	–	–	. . .	1
	Mexico	. . .	1	–	–
	Total	5 855	1 912	8 718	3 391
3104.90.00.10	Magnesium-potassium sulphate				
	United States	70 049[r]	16 216[r]	69 765	14 458
	Total	70 049[r]	16 216[r]	69 765	14 458
3104.90.00.90	Other potassic fertilizer				
	United States	5 502	1 896	8 275	2 623
	Chile	80	46	185	108
	China	86	36	203	98
	Israel	20	14	188	96
	Mexico	23	14	19	15
	Italy	–	–	12	4
	New Zealand	–	–	2	1
	Total	5 711	2 006	8 884	2 945
	Potash Chemicals				
2815.20	Potassium hydroxide (caustic potash)	18 402[r]	10 979[r]	18 855	11 177
2834.21	Potassium nitrate	6 111[r]	3 468[r]	7 912	4 673
2835.24	Potassium phosphates	1 260	1 346	1 486	1 721
2836.40	Potassium carbonates	2 085[r]	1 418[r]	2 551	1 855
2839.20	Potassium silicates	1 206	600	1 149	585
	Total potash chemicals	29 064	17 811	31 953	20 011
EXPORTS, Fertilizer Potash[1]					
3104.20	Potassium chloride, in packages weighing more than 10 kg				
	United States	8 553 080[r]	892 447[r]	8 546 315	1 125 230
	China	1 773 854	258 485	1 729 553	257 394
	Brazil	1 169 755[r]	152 511[r]	1 008 034	144 869
	Malaysia	475 071	69 209	514 758	77 066
	Japan	569 383	84 296	459 453	69 604
	Australia	249 523	35 877	299 945	45 068
	South Korea	343 503	49 996	296 385	44 421
	Taiwan	209 698	30 539	196 379	29 584
	Thailand	93 472	13 608	188 254	28 346
	New Zealand	161 928	23 287	177 097	26 883
	Italy	88 430	12 534	119 445	18 282
	Belgium	122 298	17 587	98 297	14 809

TABLE 1 (cont'd)

Item No.		1997 (tonnes)	1997 ($000)	1998p (tonnes)	1998p ($000)
EXPORTS (cont'd)					
	Vietnam	56 011	8 178	91 785	13 932
	Spain	36 935	5 735	97 165	12 192
	Indonesia	123 985	18 071	51 216	8 065
	Guatemala	36 229	5 193	53 510	7 898
	India	20 242	2 960	49 737	7 775
	Philippines	33 220	4 692	43 518	6 596
	Chile	52 436	7 265	40 036	6 046
	Colombia	32 831	4 122	35 900	5 516
	Denmark	15 750	1 773	31 468	3 765
	Cuba	72 600	8 165	25 600	3 210
	El Salvador	–	–	19 600	2 831
	Dominican Republic	17 118	2 268	18 600	2 414
	Mexico	17 539	2 217	16 955	2 143
	France	68 940	8 710	14 218	1 783
	South Africa	–	–	10 155	1 541
	Venezuela	26 761	3 912	10 500	1 322
	Fiji	16 520	2 717	5 474	861
	Argentina	4 700	678	3 000	470
	United Kingdom	9 072	1 128	72	42
	Costa Rica	51 295	7 441	–	–
	Honduras	19 250	2 189	–	–
	Ecuador	15 947	1 978	–	–
	Jamaica	4 800	566	–	–
	Panama	3 000	363	–	–
	Total	14 545 176r	1 740 697r	14 252 424	1 969 958
3104.30	Potassium sulphate, in packages weighing more than 10 kg				
	United States	7 745	3 454	10 670	5 439
	South Korea	–	–	17	102
	Australia	–	–	166	80
	Total	7 745	3 454	10 853	5 621

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available or not applicable; . . . Amount too small to be expressed; p Preliminary; r Revised.
[1] Countries are ranked in descending order of value, based on 1996 data.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, POTASH PRODUCTION AND SALES IN 1997, AND BY QUARTER, 1998

	Total 1997	1998 1st Quarter	1998 2nd Quarter	1998 3rd Quarter	1998 4th Quarter	1998 Total
	(000 tonnes, K_2O equivalent)					
Production	9 027.5	2 562.0	2 618.6	1 958.6	2 054.2	9 193.4
Sales						
North America	5 784.6	1 277.0	1 226.6	1 294.2	979.5	4 777.3
Offshore	3 723.7	940.0	1 208.8	765.2	575.2	3 489.2
Total	9 508.3	2 217.0	2 435.4	2 059.4	1 554.7	8 266.5
Ending inventories						
Mine site	460.1	460.9	532.4	630.9	950.7	n.a.
Off site	476.4	704.2	728.1	417.6	567.2	n.a.
Total	936.5	1 165.1	1 260.5	1 048.5	1 517.6	n.a.

Source: Potash and Phosphate Institute, 1998.
n.a. Not applicable.

TABLE 3. CANADA, POTASH INVENTORY, PRODUCTION, DOMESTIC SALES AND EXPORT SALES, 1998

Month	Beginning Inventory	Production	Domestic Sales			U.S. Sales			North American Sales	Offshore Exports	Total Sales
			Agriculture	Non-Agriculture	Total	Agriculture	Non-Agriculture	Total			
						(000 tonnes K_2O)					
January	936.5	897.7	9.9	1.8	11.7	375.1	50.6	425.7	437.4	314.6	752.1
February	1 038.9	807.4	38.7	2.3	41.0	423.5	46.3	469.7	510.7	243.4	754.2
March	1 053.3	856.9	20.0	3.1	23.0	248.2	57.7	305.8	328.9	381.9	710.8
Subtotal, 1st quarter		2 562.0	68.6	7.2	75.7	1 046.8	154.6	1 201.3	1 277.1	940.0	2 217.1
April	1 165.1	885.1	72.1	1.2	73.3	416.5	41.9	458.4	531.7	294.2	825.9
May	1 135.6	923.9	117.8	1.6	119.5	326.9	41.9	368.8	488.2	389.8	878.1
June	1 202.0	809.7	23.6	2.4	25.9	133.3	47.3	180.7	206.6	524.7	731.3
Subtotal, 2nd quarter		2 618.6	213.5	5.2	218.7	876.7	131.2	1 007.9	1 226.5	1 208.8	2 435.3
July	1 260.5	509.6	18.1	1.5	19.7	148.1	49.8	197.9	217.6	408.0	625.6
August	1 137.3	646.2	26.8	1.7	28.6	450.3	40.4	490.7	519.3	212.4	731.7
September	993.2	802.8	50.3	2.3	52.6	453.5	51.2	504.7	557.4	144.8	702.2
Subtotal, 3rd quarter		1 958.6	95.3	5.5	100.9	1 051.9	141.4	1 193.3	1 294.2	765.2	2 059.4
October	1 048.5	808.6	20.9	1.8	22.7	218.0	53.0	270.9	293.6	197.7	491.3
November	1 330.2	696.2	12.6	1.7	14.3	179.7	51.0	230.7	245.0	180.6	425.6
December	1 615.5	549.4	15.1	1.7	16.9	371.5	52.5	424.0	440.9	196.9	637.8
Subtotal, 4th quarter		2 054.2	48.6	5.3	53.9	769.1	156.5	925.6	979.5	575.2	1 554.7
Total		9 193.4	426.0	23.1	449.1	3 744.5	583.6	4 328.1	4 777.3	3 489.2	8 266.4

Source: Potash and Phosphate Institute.
Note: Reported stocks at year-end total 1.51791 Mt.

TABLE 4. CANADIAN POTASH, CURRENT SITUATION, 1989-98, AND FORECAST, 1999

	Actual										Forecast[1]
	1989	1990	1991	1992	1993	1994	1995	1996	1997[r]	1998[p]	1999[e]
						(000 tonnes K_2O)					
Capacity	12 045	12 045	12 045	12 180	12 180	12 235	13 220	13 310	13 400	13 410	13 410
Production	7 333	7 002	7 402	7 270	6 850	8 182	9 065	8 042	9 030	9 190	8 800
Capacity utilization (%)	61	58	61	60	56	67	69	60	67	69	66
Sales	7 124	7 190	7 056	7 025	6 863	8 517	8 635	7 970	9 510	8 265	9 000
of which: Domestic	315	396	350	370	356	385	345	355	490	450	450
United States	3 886	3 630	3 610	3 945	4 048	4 560	4 495	4 335	5 295	4 325	4 750
Offshore	2 923	3 164	3 096	2 710	2 459	3 535	3 795	3 280	3 725	3 490	3 800
Year-end stocks	1 596	1 272	1 585	1 785	1 726	1 285	1 545	1 420	935	1 520	1 300
World production	29 310	27 452	26 035	24 036	20 407	22 687	24 302	23 331	25 467	25 870	25 800
World capacity[r]	37 501	37 786	36 966	36 492	35 340	35 459	36 009	36 170	36 437	36 180	36 673
Canada/world											
Production ratio (%)	25.0	25.5	28.4	30.2	33.6	36.1	37.3	34.5	35.5	35.5	34.1
Capacity ratio (%)	32.1	31.9	32.6	33.4	34.5	34.5	36.7	36.8	36.8	37.1	36.6

Sources: Natural Resources Canada; Potash and Phosphate Institute.
[e] Estimated; [p] Preliminary; [r] Revised.
[1] Forecast by Natural Resources Canada.

TABLE 5. CANADA, POTASH MINES, CAPACITY PROJECTIONS, 1990-2003

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
							(000 tonnes K_2O)							
Agrium Inc.														
Vade (Vanscoy)	815	815	830	830	830	930	1 020	1 110	1 110	1 110	1 110	1 110	1 110	1 110
Central Canada Potash Inc.[1]														
Colonsay	830	830	830	830	–	–	–	–	–	–	–	–	–	–
International Minerals and Chemical Corporation[2]														
K1 and K2, Esterhazy (75%)	1 745	1 745	1 745	1 745	1 745	1 745	–	–	–	–	–	–	–	–
Kalium Canada, Ltd.[1,2]														
Belle-Plaine	1 245	1 245	1 245	1 245	1 300	1 410	–	–	–	–	–	–	–	–
Central Canada Potash Inc., Colonsay	–	–	–	–	830	930	–	–	–	–	–	–	–	–
Subtotal	2 990	2 990	2 990	2 990	3 875	4 065	–	–	–	–	–	–	–	–
IMC Kalium[2]														
K1 and K2, Esterhazy (75%)	–	–	–	–	–	–	1 745	1 745	1 745	1 745	1 745	1 745	1 745	1 745
Belle-Plaine	–	–	–	–	–	–	1 410	1 410	1 410	1 410	1 500	1 600	1 700	1 800
Central Canada Potash Inc., Colonsay	–	–	–	–	–	–	930	930	930	930	930	1 060	1 220	1 220
Subtotal	–	–	–	–	–	–	4 085	4 085	4 085	4 085	4 175	4 405	4 665	4 765
Potash Company of America[3]														
Patience Lake	630	630	630	–	–	–	–	–	–	–	–	–	–	–
Potash Corporation of Saskatchewan Inc.														
Allan	960	960	960	960	960	1 150	1 150	1 150	1 150	1 150	1 150	1 150	1 150	1 150
Cory	830	830	830	830	830	830	830	830	830	830	830	830	830	830
Esterhazy (25%)	580	580	580	580	580	580	580	580	580	580	580	580	580	580
Lanigan	2 090	2 090	2 090	2 090	2 090	2 335	2 335	2 335	2 335	2 335	2 335	2 335	2 335	2 335
Patience Lake	–	–	–	630	630	630	630	630	630	630	630	630	630	630
Rocanville	1 160	1 160	1 160	1 160	1 160	1 400	1 400	1 400	1 400	1 400	1 400	1 400	1 400	1 400
Subtotal	5 620	5 620	5 620	6 250	6 250	6 925	6 925	6 925	6 925	6 925	6 925	6 925	6 925	6 925
Total Saskatchewan	**10 885**	**10 885**	**10 900**	**10 900**	**10 955**	**11 940**	**12 030**	**12 120**	**12 120**	**12 120**	**12 120**	**12 440**	**12 700**	**12 800**
Potacan Mining Company of Canada[4]														
Clover Hill (Sussex)	780	780	810	810	810	810	810	810	–	–	–	–	–	–
Potash Company of America, Inc.[3]														
Penobsquis (Sussex)	380	380	470	–	–	–	–	–	–	–	–	–	–	–
Potash Corporation of Saskatchewan Inc.														
New Brunswick Division (Penobsquis)	–	–	–	470	470	470	470	470	480	480	480	480	480	478
Cassidy Lake Division (Cover Hill)	–	–	–	–	–	–	–	–	810	810	810	810	810	810
Subtotal	–	–	–	470	470	470	470	470	1 290	1 290	1 290	1 290	1 290	1 290
Total New Brunswick	**1 160**	**1 160**	**1 280**	**1 280**	**1 280**	**1 280**	**1 280**	**1 280**	**1 290**	**1 290**	**1 290**	**1 290**	**1 290**	**1 290**
Total Canada	**12 045**	**12 045**	**12 180**	**12 180**	**12 235**	**13 220**	**13 310**	**13 400**	**13 410**	**13 410**	**13 500**	**13 730**	**13 990**	**14 090**

Source: Natural Resources Canada.
– Nil.
1 Sold to Kalium Chemicals Company Limited in 1994. 2 IMC Global Inc. merged with Kalium Chemicals in 1996. 3 Sold to Potash Corporation of Saskatchewan Inc. in 1993. 4 PMC underground mine was flooded in the fall of 1997; the operation was sold to Potash Corporation of Saskatchewan Inc. in early 1998.

TABLE 6. WORLD POTASH PRODUCTION, 1993-98

	1993	1994	1995	1996	1997	1998e
			(000 tonnes K_2O)			
Brazil	173	242	223	234	272	315
Canada	6 850	8 182	9 065	8 044	9 029	9 190
Chile	35	52	52	179	235	280
China	60	90	171	150	186	170
C.I.S.[1]	4 667	5 112	5 605	5 395	6 650	6 915
France	890	870	802	751	665	420
Germany	2 860	3 286	3 278	3 334	3 423	3 585
Israel	1 309	1 259	1 326	1 500	1 488	1 670
Italy	–	–	–	–	–	–
Jordan	822	930	1 068	1 059	849	920
Spain	661	684	650	680	640	495
United Kingdom	555	580	582	618	565	610
United States	1 525	1 400	1 480	1 387	1 465	1 300e
Total	20 407	22 687	24 302	23 331	25 467	25 870

Source: Natural Resources Canada.
– Nil; e estimated.
1 Russia and Belarus.

Salt

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This review on salt has been abbreviated to include mainly statistical tables and a brief description of the Canadian salt industry.

In 1998, Canadian salt production was estimated at 13.3 Mt, a very marginal decrease over 1997. Estimated Canadian shipments of all types of salt in 1998 were 13.2 Mt, a 2.2% decrease over 1997 shipments of 13.5 Mt. In 1998, shipments from Ontario accounted for 63% of all shipments, a slight decrease in both the share and volume over 1997 shipments. Rock salt shipments accounted for 81% of total shipments, followed by salt in brines (13%) and evaporated salt (6%). The average unit value of salt shipments was estimated at $30.29/t, a 1% increase over that of 1997. In 1998, rock salt mines operated at 85% of capacity; captive brining plants and evaporated salt facilities operated at 74% and 80%, respectively. Salt operations overall ran at an average rate of 84% of capacity.

The year 1998 was relatively slow for the Canadian pulp and paper industry, which is one of the largest end users for chloralkali. Pulp mills operated at 86% of capacity in 1998, compared to 89% in 1997, and they are expected to increase their operating rate in 1999. Overall, Canadian shipments and exports of pulp, paper and paperboard were down by about 3% from 1997 levels.

Atlantic Region

Salt production in the Atlantic provinces was from an underground rock salt mine at Pugwash, Nova Scotia; an underground potash and salt mine at Sussex, New Brunswick; and a brining operation near Nappan, Nova Scotia.

In Nova Scotia, The Canadian Salt Company Limited operates an underground rock salt mine at Pugwash in Cumberland County with a rated capacity of approximately 1.2 Mt/y. Most of the salt from this mine is used for snow and ice control. At the evaporated salt plant, saturated brine is fed to a quadruple-effect vacuum pan, rated at 13 t/h, where brine solution is evaporated to produce high-quality salt crystals for use in the chemical and food industries.

In New Brunswick, Potash Corporation of Saskatchewan Inc. (New Brunswick Division) produced potash and salt at its underground mine near Sussex. Salt is extracted at a rate of about 700 000 t/y and is sold mainly to the eastern United States and eastern Canada under a sales contract with Akzo Salt Limited. Reserves are estimated to be large enough to operate for as long as potash is extracted, which is at least 25 years. The mine is now using the integrated method of utilizing salt tailings underground as fill to support the salt and potash mining operation. Approximately 1.75 Mt of salt waste from the potash operation and rock salt screen rejects are sent directly to active cut-and-fill potash stopes to be used as backfill. Clay slimes and excess brine slurries from the processing plant are also piped underground to be discharged into large cavities created by the extraction of rock salt. After the solids have settled, the clear brine solution is re-pumped to the surface for re-use. The entire operation results in a closed circuit or "zero effluent" system.

Sifto Canada Inc., a division of North American Salt Co., has a brining operation at Nappan in Cumberland County, Nova Scotia. Evaporated salt products are sold for table salt, fisheries, and water conditioning.

Quebec

There is only one operating salt producer in Quebec, Seleine Mines Inc., located on the Magdalen Islands. Seleine Mines Inc. is owned by The Canadian Salt Company Limited. In 1995, this operation was closed down as a result of water infiltration. It resumed production in 1997 and, by 1998, the mine had reached its pre-closure production level.

ONTARIO

In 1998, salt was produced from two underground rock salt mines (Goderich and Ojibway) and from brining operations at Goderich, Windsor and Amherstburg. Salt is extracted from the Salina formation.

At Goderich, Sifto Canada Inc. operates an underground rock salt mine. Mining is currently conducted approximately 537 m below the surface, 2.5 km off the shore of Lake Huron. Reserves are estimated to be about 240 Mt and the mine has an annual capacity of 5.5 Mt of salt products. The mine has now completed its conversion to the bench mining technique. In 1998, IMC Global Inc., the Chicago-based parent company of IMC Kalium, purchased the assets of Harris Chemical Group, which included Sifto Canada Inc., and became one of the largest salt operators in Canada. Sifto's salt is marketed mainly for ice control and is sold primarily in eastern Canada, the north-central United States (Great Lakes Basin), and regions accessible through the Mississippi River system. Salt produced at Goderich is also used by the chemical and water treatment industries. Evaporated salt is produced at the Sifto brining operation located near Goderich and is used mainly for the water-softening market.

The Canadian Salt Company Limited produced both rock salt from the Ojibway underground mine and vacuum salt products from brine wells near Windsor. The mine capacity is 2.7 Mt/y and current estimated reserves are 100 Mt. Rock salt is extracted using room-and-pillar mining methods from a 7.5-m unit of the Salina formation about 297 m below the surface. Brine is pumped from the 427-m and 457-m levels. Salt products include de-icing road salt (accounting for two thirds of production) and water softening, agricultural and chemical fine salt. The main markets are Canada and the midwestern United States for all salt products except chemical fine salt, which is marketed in Quebec for the manufacture of caustic soda and chlorine. In 1994, The Canadian Salt Company Limited acquired the mineral rights to Fighting Island in the Detroit River and, consequently, it now has sufficient reserves for at least 40 years.

In the vicinity of Amherstburg, General Chemical Canada Ltd. operates a brining operation for the manufacture of sodium carbonate and by-product calcium chloride. Because of the important quantities of sodium chloride resulting from the calcium chloride stream, the company is currently assessing the possibility of profiting from this by-product sodium chloride.

PRAIRIE PROVINCES

In Saskatchewan, four companies produced salt from the Middle Devonian Prairies formation in 1998. International Minerals & Chemical Corporation (Canada) Global Limited, a subsidiary of IMC Kalium, supplied by-product rock salt from its potash operation at Esterhazy to Kayway Salt, who is distributing it locally for road de-icing. Kayway Salt is presently considering the U.S. market, especially North Dakota, Wisconsin and Montana. Sifto Canada Inc. operated a brining operation near Unity for the production of fine vacuum pan salt. Uses of the salt produced at Unity are for water softening, for agriculture, in food processing, and some de-icing salt for local use. The Canadian Salt Company Limited at Belle-Plaine produced evaporated salt from by-product brines sourced from an adjacent potash solution mine operated by IMC Kalium Canada Limited, a subsidiary of IMC Kalium. Most of the production goes towards water softening; other uses include for agriculture and in food processing and ice control. Saskatoon Chemicals, a division of Weyerhaeuser Canada Ltd., produced brines from wells near Saskatoon for the manufacture of caustic soda, chlorine and sodium chlorate to be used internally in its pulp and paper operations.

Nu Salt Corp. processed salt-rich potash tailings from Potash Corporation of Saskatchewan's Rocanville operation. The potash tailings are dried and bulk delivered to local distributors for road de-icing. Other applications are for cattle feed and water softening. Nusalt is currently seeking new markets, such as the United States.

IMC Central Canada Potash Limited, a subsidiary of IMC Kalium, began salt production in September 1992. Salt is recovered from its potash tailings. The main product is de-icing salt, which accounts for 80% of production; the remaining 20% is for general use. Products are mostly sold locally in British Columbia, Alberta and Saskatchewan. The company is now moving to the commercial market where its products can be found under the Canadian registered trademark "Sabre." Salt is bagged at three locations. The company is seeking new markets in both Canada and the United States.

In Alberta, four producers operated brining operations. At Fort Saskatchewan near Edmonton, Dow Chemical Canada Inc. extracted salt brines for the manufacture of chloralkali and, at Lindberg, The Canadian Salt Company Limited produced fine vacuum pan salt. Near Bruderheim, two companies, CXY Chemicals Canada Ltd. Partnership (formerly known as Canadian Oxy Ltd.) and Albchem Industries, operated solution mines to produce sodium chlorate used mostly for pulp bleaching in the prairie provinces and western Canada.

BRITISH COLUMBIA

There was no production of salt in this province where three companies operated four chloralkali

plants. These operations used solar salt imported from Mexico, the United States and Chile.

Consumption

In Canada, since the early 1990s, the apparent consumption of salt varied between 9 and 11 Mt/y compared to 7 Mt/y in the early 1980s. In 1998, the apparent consumption of salt in Canada was estimated at 10 Mt, a 10% decrease over 1997. In 1998, imports, mainly in British Columbia, Ontario and Quebec, accounted for about 9.8% of total domestic consumption. Chemical and de-icing uses accounted for between 90% and 95% of Canadian consumption, with the remainder being used for water conditioning, food processing, fisheries, and other industrial uses. Most of the salt used as a de-icing agent is consumed in Ontario, Quebec and Atlantic Canada. The average yearly consumption of salt in Canada for ice and snow control ranges between 3.2 and 4.5 Mt.

Some 60% of world salt consumption is as a chemical raw material, followed by table salt (20%) and road de-icing salt (10%); the remaining 10% is used in animal feed and water treatment. The consumption pattern differs in North America where the chemical industry consumes about 56% of total production, followed by highway usage (24%) and the food industry (7%).

Salt Uses

Chloralkali and Related Uses

The industrial chemicals industry consumes salt for the manufacture of chloralkali such as caustic soda (sodium hydroxide), chlorine, and sodium chlorate. Salt for four caustic soda and chlorine plants in Canada is obtained from on-site brining and natural brines; other plants use mined rock salt or imported solar or evaporated salt. Other industrial chemicals that require significant quantities of salt include sodium bicarbonate, sodium chlorite, sodium hypochlorite, sodium carbonate (soda ash), and calcium chloride.

Most pulp and paper mills in Canada have carried out extensive process modifications and improvements in effluent treatment. Several have opted to reduce chlorine usage by installing other bleaching processes such as extended lignification, oxygen delignification, sodium chlorate bleaching, integrated chlorine dioxide with hydrochloric acid recycling, and ozone and hydrogen peroxide bleaching processes. Although environmentalists consider sodium chlorate to be a step in the right direction in the move away from chlorine, they still would like the pulp and paper industry to adopt dioxin-free bleaches such as oxygen and hydrogen peroxide.

De-Icing

Sodium chloride, or salt, remains the primary de-icing agent. Different de-icers are used in accordance with site requirements. On streets and highways, rock salt, calcium chloride-salt mixtures, salt brines, and mechanical measures (plowing and blowing) are mostly used. On bridges, salt, sand-salt mixtures, and salt alternative methods are used; pavement heating and non-corrosive chemicals with corrosion inhibitors are under investigation. On runways, non-corrosive compounds are used and comprise urea, formamide, and glycols. In residential and commercial areas, rock salt, potassium chloride (potash), calcium chloride, and various combinations of these materials with abrasives (sand and gravel) are regularly used. Calcium chloride is the second most used de-icer, being effective at temperatures ranging between -10° and -20°C; this chemical is usually mixed with salt at a 2-4% rate. The use of abrasives is mostly limited to highways and residential areas; a mixture of coarse sand and small crushed stone is spread to improve the skid resistance of slippery roads.

Growing concerns over the environment and the corrosion of infrastructure, such as bridge decks and parking lots, have led to numerous experiments with de-icing salt substitutes. Research on alternatives has focused on abrasive mixes, magnesium chloride, ammonium compounds, tetrapotassium pyrophosphates, calcium magnesium acetate (CMA), sodium formate, isopropyl alcohol, ethylene glycol, and technical urea. Studies have also been conducted on non-chemical treatments, including a series of measures that are used mainly in Europe such as ice-retardant pavement surfacing and roadway heating. The effects of salt-spreading on the environment depend on a variety of factors such as weather conditions, road characteristics, traffic loads, winter maintenance methods, and local topography. Environmental effects may include adverse impacts on plant growth and crop productivity in the immediate vicinity of highways, as well as higher salinity levels in streams and groundwater systems. For many years, provincial and regional agencies in charge of road maintenance have pursued the objective of optimizing the use and selection of ice and snow control methods. Cost, operational reliability, public safety, and environmental considerations have all resulted in improvements to existing methods and better road safety and rideability.

As a result of these concerns, Environment Canada has decided to put "Road Salts" on the second Priority Substances List (PSL2) that was announced on December 16, 1995. The inclusion of road salts is the result of the recommendations outlined in the *Report of the Ministers' Expert Advisory Panel on the Second Priority Substances List under CEPA* that was issued in October 1995. In the rationale for including road salts in PSL2, while recognizing the benefits of their

usage, the Panel cites "evidence of adverse local environmental effects to groundwater and to plant and animal life." Because of these consequences and the widespread use of road salts, and "their release in large volume into the Canadian environment, the panel believes that an assessment is needed to determine their ecological effects."

Other Uses

Other sectors that consume salt include water softening, food processing, and the fisheries industry, which together account for close to 5% of total salt consumption in Canada. The North American salt industry is currently investigating the potential of using salt in several cosmetic and body products, a market that has grown significantly in Japan where some body shampoos can contain up to 50% salt.

TRADE

Imports of salt in 1998 were 0.98 Mt valued at $38.3 million, which in volume represented a 22.5% drop compared to 1997, but represented only a 2% decrease in value. In 1998, the import unit price increased 26.1% to $39.20/t from $31.09/t in 1997. The origin of imports in 1998 was from 47 countries, but mainly from the United States (59%), Mexico (28%), Chile (5%) and the Bahamas (2%), for deliveries in Ontario (51%), British Columbia (41%), Quebec (4%) and the rest of Canada (4%).

Exports of salt in 1998 were 4.2 Mt valued at $116.7 million which, when compared to 1997 figures of 3.6 Mt valued at $102 million, represents an increase of 15% in volume and 14% in value. The unit value decreased by 0.5% from $28.08/t in 1997 to $27.94/t in 1998. Exports of salt products in 1998 were to eight countries, but principally to the United States, which accounted for 99.9%. Deliveries were shipped mainly from Ontario (83%) and Quebec (13%).

WORLD PRODUCTION

The total world production of salt in 1998 was estimated at 200 Mt, down slightly from 1997. Salt is produced in numerous countries, but the bulk of the production is from about 13 countries, of which the United States is the principal producer. The United States accounted for 21%, while China accounted for 15%, Germany for 8%, Canada for 7%, and India for 5%.

United States

Domestic salt production in the United States was estimated to be 42.1 Mt in 1998, up from 41.4 Mt in 1997; the total value was estimated to be in excess of US$965 million. Twenty-eight companies operated sixty-eight plants in fourteen states. Apparent consumption in 1997 was 49.0 Mt, down 7% from the 52.8 Mt in 1996; the 1998 figure is estimated to be marginally higher at 49.2 Mt. The distribution of salt sold or used by type, in 1995, was brine sales, 51%; rock salt, 31%; evaporated salt, 9%; and solar salt, 9%. The chemical industry consumed about 45% of the total salt sold, while road and ice control usage accounted for 30%, food and agricultural sectors for 7%, general industrial for 7%, and others for 11%. The 1998 estimated average unit value of salt from brine decreased 10% to US$6.00/t and the average unit value for rock salt shipments decreased 13% to US$17.90/t.

U.S. salt imports in 1998 were estimated at 9.3 Mt, a 1.5% increase over 1997. The major exporting countries were Canada (39%), followed by Chile (20%), Mexico (20%) and the Bahamas (12%). The net import reliance of the United States for 1998 was estimated at 17% of apparent consumption. Salt exports increased by 7% to 0.8 Mt.

INTERNATIONAL TRADE

Salt is a widespread, low-value bulk commodity. It is relatively easy to extract and transportation represents a significant proportion of the total delivered price. As a consequence, international trade in salt is small relative to world production, i.e., about 20% of total world production. Trade in the Pacific area currently accounts for one half of seaborne movements, followed by North America (24%) and northwestern Europe (20%). Australia is expected to remain the major supplier to Japan, while Mexico will continue to export mainly to Japan and North America. Imports into the European Union are expected to remain minimal as this region is essentially self-sufficient. However, only facts relevant to the United States are of interest to the Canadian salt industry.

OUTLOOK

In 1999, domestic production and consumption of salt is forecast to remain stable. Imports of salt are likely to remain at 1998 levels. Rock salt prices are expected to increase by about 3%, and the price of value-added products should perform differently according to the product.

Despite environmental pressures and the recent inclusion on PSL2, de-icing salt will continue to be the major de-icing agent because of its low price. The optimization of spreading rates, in combination with the search for adequate abrasive mixtures, will continue to be evaluated. The winter of 1998/99, although considered a harsh winter in the northeastern United States, can only be considered a normal

winter for Canada and therefore should not result in above-average demand for de-icing salt in Canada, but may lead to increased exports to the United States.

The pulp and paper industry, which is the major consumer of chloralkali, is expected to improve in 1999 with a resulting increase in operating rates. Demand in the chloralkali sector is forecast to grow at a marginal rate of 1-2%. A decline in the consumption of chloralkali in the pulp and paper sector will likely be offset by an anticipated continued growth in the polyvinyl chloride (PVC) sector (in which sales of chlorine will register an annual increase of 5-6%). PVC output should continue to grow in 1999, mainly because of strength in the export market and the strengthening of the construction sector.

Sales of salt in the fisheries and food industries are believed to have now reached a plateau, but for different reasons. The Canadian fisheries seem to have completed their round of cuts in fish quotas. In the food industry, the concerns over salt in diets seem to be less important to the consumers (many products presented are already low in sodium content) and no further reduction is expected. Salt substitutes are still making some gains in this market.

A new but restricted market is currently being investigated by the industry. This market results from a Japanese fashion to use salt in many cosmetic and body-care products. The ageing but wealthy population of baby-boomers could be a good target for this new industry.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of March 31, 1999.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2501.00	Salt (including table salt and denatured salt) and pure sodium chloride, whether or not in aqueous solution or containing added anticaking or free-flowing agents; sea water				
2501.00.10	Table salt made by an admixture of other ingredients when containing 90% or more of pure sodium chloride	2.5%	Free	Free	Free
2501.00.90	Other	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999.

TABLE 1. CANADA, SALT SHIPMENTS AND TRADE, 1996-98

Item No.		1996		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
SHIPMENTS							
	By type						
	Mined rock salt	9 499 189	268 040	10 923 966	310 547	10 675 654	304 395
	Fine vacuum salt	853 858	84 343	863 112	84 834	844 281	85 077
	Salt content of brines used or shipped	1 895 430	7 435	1 709 778	10 128	1 671 875	10 049
	Total	12 248 477	359 818	13 496 856	405 509	13 191 810	399 520
	By province						
	Nova Scotia	x	x	x	x	x	x
	New Brunswick	x	x	x	x	x	x
	Quebec	x	x	x	x	x	x
	Ontario	8 402 232	2 561 156	8 968 029	275 229	8 315 286	257 856
	Saskatchewan	791 929	32 364	837 625	32 434	701 906	30 729
	Alberta	1 317 920	16 612	1 093 323	x	1 052 529	16 399
	Total	12 248 477	359 818	13 496 856	405 509	13 191 810	399 520
IMPORTS							
2501.00	Salt[1]						
	United States	793 801	30 216	796 743	31 838	581 299	28 848
	Mexico	272 597	4 810	393 019	5 489	272 071	5 335
	Chile	42 550	515	46 407	560	88 813	2 169
	Bahamas	10 463	233	11 970	227	22 574	551
	France	2 145	272	3 920	152	2 104	236
	Germany	1 750	230	3 258	276	4 608	106
	Other countries	14 296	650	7 505	718	6 676	1 101
	Total	1 137 604	36 926	1 262 822	39 260	978 145	38 346
	By province of clearance						
	Newfoundland	7 951	249	4 225	177	16 444	541
	Nova Scotia	6 689	119	8 305	159	6 645	115
	New Brunswick	52	9	91	10	2 938	863
	Quebec	393 550	9 898	292 022	7 671	42 020	2 428
	Ontario	320 808	17 560	372 960	20 441	502 235	24 264
	Manitoba	4 725	487	4 101	457	3 862	529
	Saskatchewan	1 246	225	1 135	276	1 368	396
	Alberta	7 170	825	8 401	800	6 421	565
	British Columbia	395 413	7 554	571 581	9 274	396 211	8 646
	Total	1 137 603	36 926	1 262 821	39 264	978 145	38 348
EXPORTS							
2501.00	Salt[1]						
	United States	3 812 315	108 236	3 631 586	101 676	4 177 499	116 609
	Panama	1 860	254	101	25	202	47
	Costa Rica	296	72	1 210	58	23	14
	Other countries	2 317	487	1 112	270	157	67
	Total	3 816 788	109 049	3 634 009	102 029	4 177 881	116 737

Sources: Natural Resources Canada; Statistics Canada.
p Preliminary; x Confidential.
1 Includes table salt, pure sodium chloride and seawater salt.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, SALT SHIPMENTS AND TRADE, 1980-98

	Producers' Shipments					
	Mined Rock	Fine Vacuum	In Brine and Recovered in Chemical Operations	Total	Imports	Exports
			(tonnes)			
1980	4 507 416	781 428	2 134 010	7 422 854	1 151 203	1 637 601
1981	4 371 314	764 037	2 107 243	7 242 594	1 254 992	1 507 710
1982	5 223 073	773 086	1 944 172	7 940 331	1 526 879	1 721 893
1983	5 846 994	714 464	2 040 925	8 602 383	814 250	1 914 629
1984	7 030 664	754 675	2 450 060	10 235 399	1 053 217	2 530 038
1985	6 608 739	805 209	2 670 749	10 084 697	1 255 518	2 263 076
1986	6 867 287	815 044	2 649 515	10 331 846	1 328 298	2 502 518
1987	6 670 863	866 475	2 591 715	10 129 053	1 112 102	1 924 686
1988	7 126 762	783 368	2 777 050	10 687 180	1 202 219	3 030 124
1989	7 548 732	821 284	2 788 395	11 158 411	2 360 432	2 137 321
1990	7 704 499	778 428	2 708 458	11 191 385	2 095 321	1 897 816
1991	8 615 755	799 563	2 455 541	11 870 859	1 202 880	2 783 021
1992	7 912 989	770 370	2 404 667	11 088 026	1 041 424	2 650 921
1993	8 073 435	817 859	2 101 711	10 993 005	1 051 096	3 079 298
1994	9 446 002	822 181	1 975 704	12 243 887	940 131	3 638 674
1995	8 077 661	850 676	2 029 047	10 957 384	1 294 996	2 986 802
1996	9 499 189	853 858	1 895 430	12 248 477	1 137 604	3 816 788
1997	10 923 966	863 112	1 709 778	13 496 856	1 262 822	3 634 009
1998p	10 675 654	844 281	1 671 875	13 191 810	978 145	4 177 881

Sources: Natural Resources Canada; Statistics Canada.
p Preliminary.

TABLE 3. WORLD SALT PRODUCTION, 1993-98

Countries	1993	1994	1995	1996	1997	1998e
			(000 tonnes)			
United States	39 300	39 800	42 200	42 300	41 400	42 100
Chinae	29 500	29 700	29 800	29 000	29 300	30 000
Germany	12 688	10 273	15 224	15 907	15 700	15 000
Canada	10 993	12 244	10 957	12 248	13 497	13 192
India	9 500	9 500	9 500	9 500	9 500	9 400
Australia	7 737	7 685	8 148	7 905	8 722	8 800
Mexico	7 490	7 458	7 670	8 508	7 933	7 900
France	6 980	7 536	7 539	7 860	7 160	7 200
United Kingdom	6 790	7 000	6 650	6 610	6 600	6 600
Brazil	6 180	6 043	5 800	5 384	5 520	5 700
Spain	3 410	4 932	4 776	4 000	4 000	4 100
Poland	3 817	4 074	4 214	4 163	3 968	4 000
Italy	3 730	3 953	3 552	3 600	3 600	3 600
Other	38 885	40 802	42 970	44 015	44 100	42 408
Total	187 000	191 000	199 000	201 000	201 000	200 000

Sources: Natural Resources Canada; U.S. Geological Survey.
e Estimated.

TABLE 4. 1998 CANADIAN SALT PRODUCERS

Company	Location/ Initial Production	Annual Production Capacity	Remarks
		(000 t/y)	
Albchem Industries Ltd.	Bruderheim, Alta./1991	35	Brining to produce sodium chlorate.
CXY Chemicals Canada Ltd. Partnership	Bruderheim, Alta./1991	37	Brining to produce sodium chlorate.
Canadian Salt Company Limited, The	Pugwash, N.S./1959	1 200	Rock salt mining to a depth of 305 m.
	Pugwash, N.S./1962	110	Dissolving rock salt fines for vacuum pan evaporation.
	Îles-de-la-Madeleine, Que./1982	1 700	Rock salt mining to a depth of up to 273 m.
	Ojibway, Ont./1955	2 700	Rock salt mining at a depth of 300 m.
	Windsor, Ont./1892	200	Brining, vacuum pan evaporation.
	Belle-Plaine, Sask./1969	200	Producing fine salt from by-product brine from nearby potash operation owned by IMC Kalium Canada.
	Lindbergh, Alta./1968	150	Brining, vacuum pan evaporation.
Dow Chemical Canada Inc.	Fort Sask., Alta./1968	1 400	Brining to produce caustic soda and chlorine.
General Chemical Canada Ltd.	Amherstburg, Ont./1919	690	Brining to produce sodium carbonate.
IMC Kalium	Colonsay, Sask./1992	130	By-product rock salt from potash operation.
	Esterhazy, Sask./1962	180	By-product rock salt from potash mine for use in snow and ice control.
Nu Salt Corp.	Rocanville, Sask./1990	200	By-product rock salt from potash tailings.
	Vanscoy, Sask./1988	200	By-product rock salt from potash tailings.
Potash Corporation of Saskatchewan – New Brunswick Division	Sussex, N.B./1980	700	Rock salt produced in association with potash for use in snow and ice control.
Sterling Pulp Chemicals (Sask) Ltd.	Saskatoon, Sask./1968	90	Brining to produce caustic soda, chlorine and sodium chlorate.
Sifto Canada Inc.	Nappan, N.S./1947	100	Brining for vacuum pan evaporation.
	Goderich, Ont./1959	5 500	Rock salt mining at a depth of 536 m.
	Goderich, Ont./1880	120	Brining for vacuum pan evaporation.
	Unity, Sask./1949	180	Brining vacuum pan evaporation. Fusion plant closed in 1991.
Total		15 822	

Sources: Natural Resources Canada, 1998; company surveys.

Stone

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The volume of all types of stone shipped in Canada in 1998 was approximately 96 Mt based on preliminary figures. This amount is about 3% lower than in 1997. The reported value of total shipments in 1998 was about $646 million, marginally higher than the previous year. Shipments served a very wide range of uses related to dimension stone, chemical and metallurgical grades of stone, pulverized stone, and crushed stone.

Shipments of limestone for producing cement and lime are reported separately in chapters on *Cement* and *Lime*. Also, additional detailed information on regular aggregates, including crushed stone and sand and gravel, as well as lightweight aggregates, including expanded shales/clays, perlite, vermiculite and pumice, is included in a separate chapter entitled *Mineral Aggregates*.

Dimension or ornamental stone relates to a variety of rock types that can be cut, shaped or simply selected for a broad range of construction/engineering, architectural or monumental requirements. The types of stone available are dependent on local geology, but mainly include granite, limestone, marble, sandstone and slate, as summarized in Tables 3 to 8 inclusive. The term "granite," as commercially applied, includes true granite, granodiorite, gneiss, and other medium- to coarse-grained igneous rocks. However, "black granite" includes anorthosite and other dark-coloured igneous rocks. Limestone and marble are often confused, marble being the metamorphosed equivalent of the former and usually including both dolomitic and calcitic varieties. As an industrial term, marble is used for recrystallized calcareous rock capable of taking a polish.

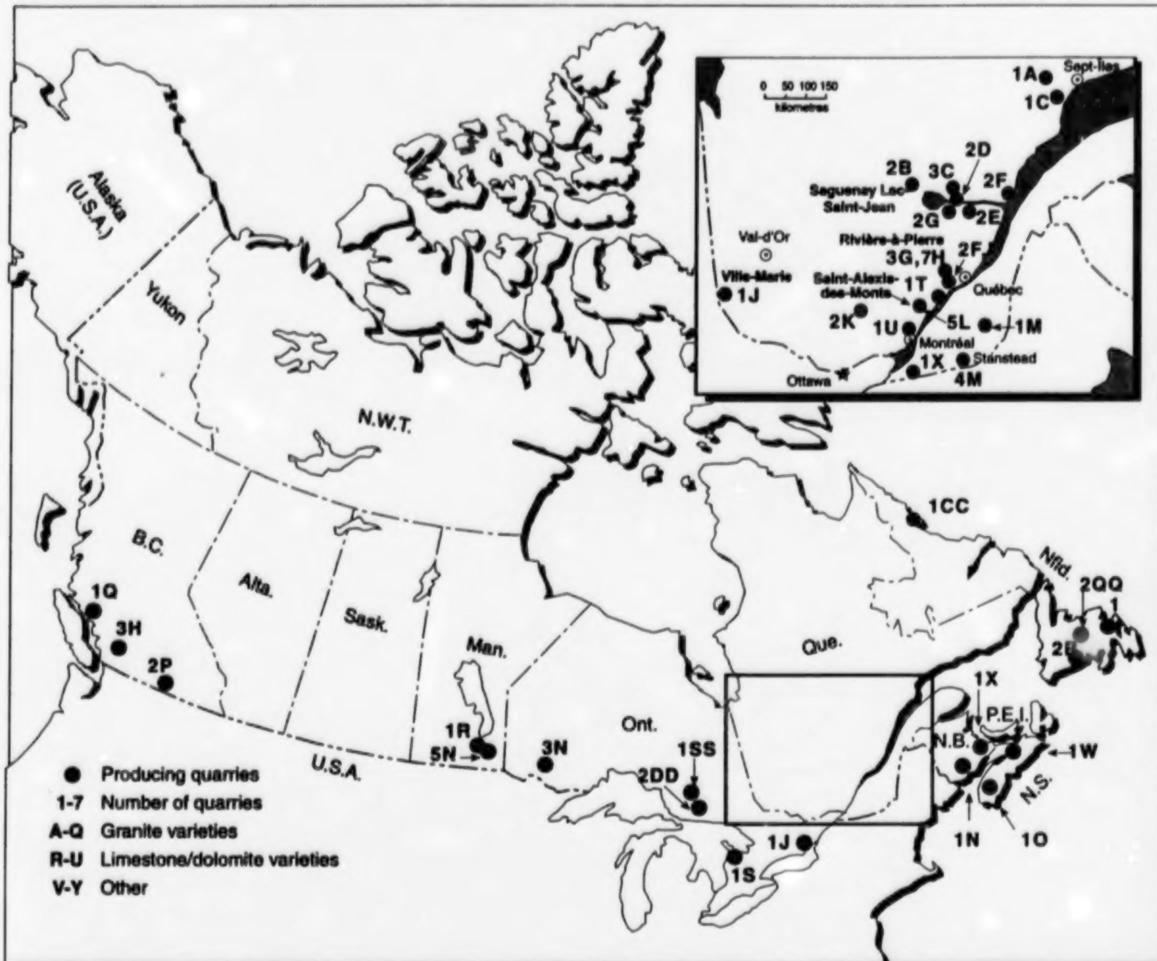
The value of exports of rough granite declined to $14.7 million in 1998 (Table 1), a 30% decrease since 1996. However, exports of value-added worked granite for building and monumental needs, mainly to the United States, increased to nearly $50 million, representing nearly a twofold increase since 1996. Plant modernizations by several stone producers across Canada have increased the availability of high-quality finished products at competitive prices. The value of output of all worked construction- and monument-related granite (f.o.b. manufacturing plant) serving both domestic and international markets is expected to be maintained at about $120 million annually.

It is expected that growth in the use of dimension stone in Canada will continue in 1999/2000, mainly based on the positive outlook for all construction, including new expenditures for office buildings. Growth in exports of worked granite and other stone products is expected based on the continued expansion of U.S. markets. Shipments and exports of rough granite are also expected to increase as economies improve in Southeast Asia. Slate is becoming more important in world markets for its natural unpolished appearance, its non-slippery and multi-coloured durable surfaces, and its relatively low price.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of February 1, 1999.

Figure 1

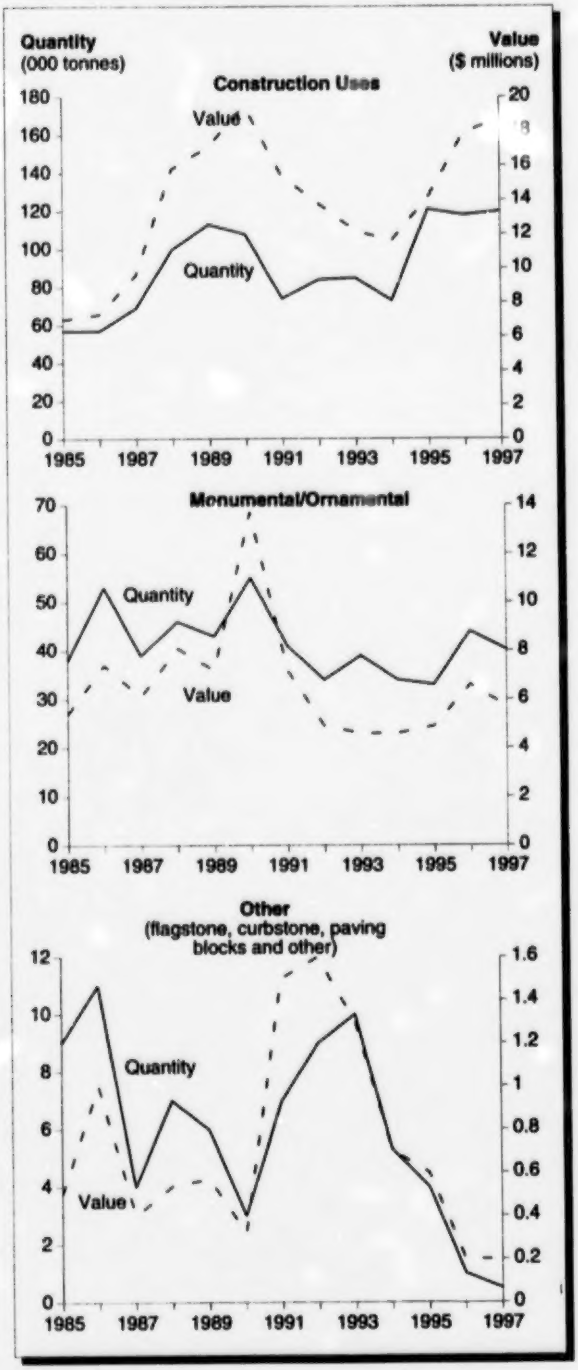
Canada, Architectural and Monumental/Ornamental Stone-Producing Centres, 1997



A Fine-grained pinkish-grey banded gneiss
B Medium-grained pink granite
C Coarse-grained black anorthosite
CC Medium-grained "Reflect blue" anorthosite
D Medium-grained black gabbroic anorthosite
DD Blue-grey, and black and white anorthosite
E Medium-grained pinkish-grey quartz monzonite
F Fine-grained pink granitic gneiss
G Coarse-grained green charnockite
H Coarse-grained pink-grey or brown-grey granite
I Medium-grained grey dioritic gneiss
J Medium-grained red granite
K Fine-grained pink aplite
L Coarse-grained brown or red quartz monzonite
M Medium-grained grey granite
N Medium-grained pink, brown or gold granites
O Fine-grained blue-grey granite
P Coarse coral pink granite
Q Medium-grained blue-grey granite
QQ Medium-grained gabbro
R Light-coloured mottled dolomitic limestone (Tyndall)
S Fine-medium crystalline blue-grey to buff marble/dolostone (Arriscraft)
SS Fine-grained, multicoloured pre-Cambrian marble
T Medium-grained light brownish-grey limestone (Deschambault)
U Medium-grained blue-grey limestone (Chazy)
V Medium-grained olive sandstone
W Fine-medium-grained olive-brown and blue-grey sandstone
X Fine-medium-grained white to buff sandstone (Potsdam)
Y Very fine-grained varicoloured slate

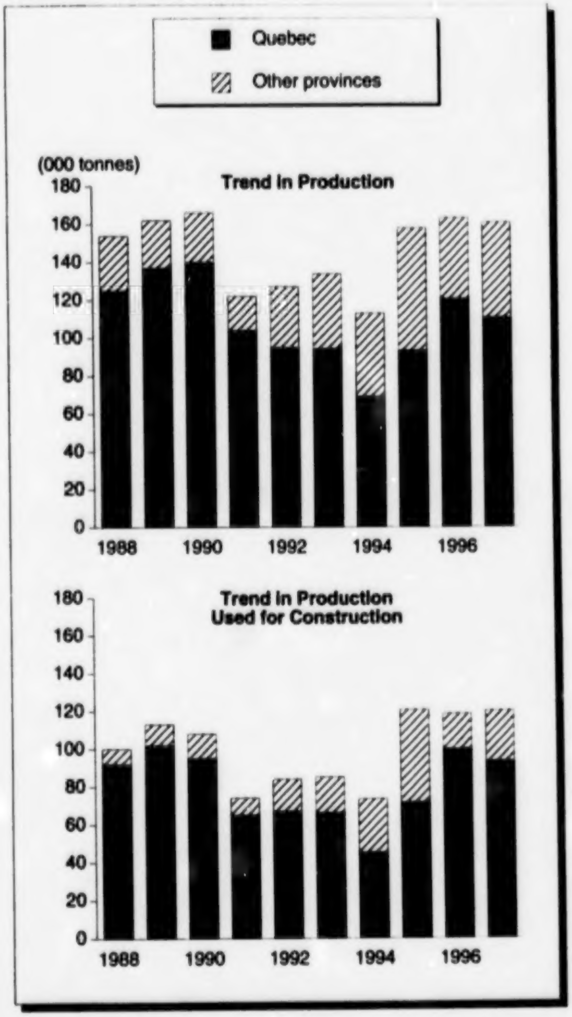
Source: Mainly provincial departments of Mines and Energy.

Figure 2
Canada, Production of Rough Granite (Sold and Used by Producers), 1985-97



Sources: Natural Resources Canada; Statistics Canada.

Figure 3
Canada, Trends in Production of Rough Granite, 1988-97



Sources: Natural Resources Canada; Quebec Ministry of Natural Resources.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2514.00	Slate, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape				
2514.00.10	Merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape	3.5%	Free	Free	Free
2514.00.90	Other	Free	Free	Free	Free
25.15	Marble, travertine, ecaussine and other calcareous monumental or building stone of an apparent specific gravity of 2.5 or more, and alabaster, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape				
	Marble and travertine:				
2515.11.00	Crude or roughly trimmed	Free	Free	Free	Free
2515.12.00	Merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape	Free	Free	Free	Free
2515.20	Ecaussine and other calcareous monumental or building stone; alabaster				
2515.20.10	Crude or roughly trimmed	Free	Free	Free	Free
2515.20.20	Merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape	3.5%	Free	Free	Free
25.16	Granite, porphyry, basalt, sandstone and other monumental or building stone, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape				
	Granite:				
2516.11.00	Crude or roughly trimmed	Free	Free	Free	Free
2516.12	Merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape	Free-3.5%	Free	Free	Free
	Sandstone:				
2516.21.00	Crude or roughly trimmed	Free	Free	Free	Free
2516.22.00	Merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape	3.5%	Free	Free	Free
2516.90	Other monumental or building stone				
2516.90.10	Crude or roughly trimmed	Free	Free	Free	Free
2516.90.20	Merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape	3.5%	Free	Free	Free
25.17	Pebbles, gravel, broken or crushed stone, of a kind commonly used for concrete aggregates, for road metalling or for railway or other ballast, shingle and flint, whether or not heat-treated; macadam of slag, dross or similar industrial waste, whether or not incorporating the materials cited in the first part of the heading; tarred macadam, granules, chippings and powder, of stones of heading nos. 25.15 or 25.16, whether or not heat-treated				
2517.10.00	Pebbles, gravel, broken or crushed stone, of a kind commonly used for concrete aggregates for road metalling or for railway or other ballast, shingle and flint, whether or not heat-treated	Free	Free	Free	Free
2517.20.00	Macadam of slag, dross or similar industrial waste, whether or not incorporating the materials cited in subheading no. 2517.10	Free	Free	Free	Free
2517.30.00	Tarred macadam	6.5%	Free	Free	Free

TARIFFS (cont'd)

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
	Granules, chippings and powder, of stones of heading nos. 25.15 or 25.16, whether or not heat-treated:				
2517.41.00	Of marble	Free	Free	Free	Free
2517.49	Other				
2517.49.10	Limestone roofing granules	Free	Free	Free	Free
2517.49.90	Other	Free	Free	Free	Free
6801.00.00	Setts, curbstones and flagstones of natural stone (except slate)	3.5%	Free	Free	Free
68.02	Worked monumental or building stone (except slate) and articles thereof, other than goods of heading no. 68.01; mosaic cubes and the like, of natural stone (including slate), whether or not on a backing; artificially coloured granules, chippings and powder, of natural stone (including slate)				
6802.10	Tiles, cubes and similar articles, whether or not rectangular (including square), the largest surface area of which is capable of being enclosed in a square which is less than 7 cm; artificially coloured granules, chippings and powder				
6802.10.10	Roofing granules, artificially coloured	Free	Free	Free	Free
6802.10.90	Other	8%	5%	Free	Free
	Other monumental or building stone and articles thereof, simply cut or sawn, with a flat or even surface:				
6802.21.00	Marble, travertine and alabaster	3.5%	Free	Free	Free
6802.22.00	Other calcareous stone	5%	Free	Free	Free
6802.23.00	Granite	3.5%	Free	Free	Free
6802.29.00	Other stone	5%	Free	Free	Free
	Other:				
6802.91.00	Marble, travertine and alabaster	6%	Free	Free	Free
6802.92.00	Other calcareous stone	6.5%	3%	Free	Free
6802.93.00	Granite	6.5%	6.5%	Free	Free
6802.99.00	Other stone	6.5%	6.5%	Free	Free
6803.00	Worked slate and articles of slate or of agglomerated slate				
6803.00.10	Roofing slate; slate for use in the manufacture of billard tables	Free	Free	Free	Free
6803.00.90	Other	6.5%	6.5%	Free	Free
68.04	Millstones, grindstones, grinding wheels and the like, without frameworks, for grinding, sharpening, polishing, trueing or cutting, hand sharpening or polishing stones, and parts thereof, of natural stone, of agglomerated natural or artificial abrasives, or of ceramics, with or without parts of other materials				
6804.10.00	Millstones and grindstones for milling, grinding or pulping	6.5%	Free	Free	Free
6804.23.00	Of natural stone	6.5%	Free	Free	Free

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999.

TABLE 1. CANADA, STONE EXPORTS AND IMPORTS, 1996-98

Item No.		1996		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
EXPORTS							
2514.00	Slate, whether or not roughly trimmed or merely cut, etc.	145	143	145	236	173	209
2515.11	Marble and travertine, crude or roughly trimmed	635	332	125	59	474	377
2515.12	Marble and travertine, merely cut, by sawing or otherwise, into blocks, etc.	51	34	77	55	1 029	554
		(cubic metres)		**(cubic metres)**		**(cubic metres)**	
2516.11	Granite, crude or roughly trimmed	36 397	19 627	40 714	14 794	23 755	12 910
		(tonnes)		**(tonnes)**		**(tonnes)**	
2516.12	Granite, merely cut, by sawing or otherwise, into blocks, etc.	3 765	1 321	6 214	1 600	5 323	1 830
		(cubic metres)		**(cubic metres)**		**(cubic metres)**	
2516.21	Sandstone, crude or roughly trimmed	10	3	957	145	4	20
		(tonnes)		**(tonnes)**		**(tonnes)**	
2516.22	Sandstone, merely cut, by sawing or otherwise, into blocks, etc.	27	40	150	54	208	214
2516.90	Monumental or building stone, n.e.s.	7 442	1 370	8 556	1 760	8 349	2 140
2517.10	Pebbles, gravel, broken or crushed stone used for aggregates, etc.	2 745 623	20 079	3 229012	25 716	3 194 913	29 310
2517.41	Marble granules, chipping and powder of 25.15 or 25.16, heat-treated or not	31 778	3 556	135 366	18 275	244 573	27 275
2517.49	Granules, chippings and powder, n.e.s. of 25.15 or 25.16, heat-treated or not	113 179	697	1 465	138	1 732	206
6801.00	Setts, curbstones and flagstones of natural stone (except slate)	. .	289	. .	446	. .	686
6802.10	Tiles, etc., rectangular or square not more than 7 cm, etc., artificially coloured granules, chippings and powder	. .	1 749	. .	1 705	. .	3 667
6802.21	Monumental or building stone, cut or sawn, flat or even, marble, travertine and alabaster	. .	17	. .	134	. .	383
6802.22	Monumental or building stone, cut or sawn, flat or even, other calcareous stone	. .	318	. .	129	. .	191
6802.23	Monumental or building stone, cut or sawn, flat or even, granite	. .	2 373	. .	2 684	. .	3 446
6802.29	Monumental or building stone, cut or sawn, flat or even, n.e.s.	. .	359	. .	758	. .	1 204
6802.91	Worked monumental or building stone, n.e.s., marble, travertine or alabaster	. .	1 411	. .	1 615	. .	1 437
6802.92	Worked monumental or building stone, n.e.s., calcareous stone, n.e.s.	. .	305	. .	860	. .	2 078
6802.93.10	Worked building stone of granite	. .	3 977	. .	15 376	. .	16 257
6802.93.90	Worked monumental or building stone, n.e.s., granite	. .	23 100	. .	30 578	. .	33 187
6802.99	Worked monumental or building stone, n.e.s.	. .	11 345	. .	15 040	. .	23 844
6803.00	Worked slate and articles of slate or agglomerated slate	. .	4 341	. .	4 755	. .	4 720
6804.10	Millstones and grindstones for milling, grinding or pulping	. .	5 939	. .	4 969	. .	5 027
6804.23	Millstones, grindstones, etc., of natural stone	. .	1 366	. .	3 271	. .	2 159

TABLE 1 (cont'd)

Item No.		1996		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
IMPORTS							
2514.00	Slate, whether or not roughly trimmed or merely cut, etc.	3 849	839	3 539	1 258	3 074	1 317
2515.11	Marble and travertine, crude or roughly trimmed	2 465	606	1 572	640	1 461	760
2515.12	Marble and travertine, merely cut, by sawing or otherwise, into blocks, etc.						
2516.11	Granite, crude or roughly trimmed	46 627	12 889	50 318	14 489	70 554	20 080
2516.12	Granite, merely cut, by sawing or otherwise, into blocks, etc.	6 868	2 429	4 321	1 546	4 632	2 924
2516.21	Sandstone, crude or roughly trimmed	6 414	946	5 021	700	3 484	442
2516.22	Sandstone, merely cut, by sawing or otherwise, into blocks, etc.	5 125	1 180	4 953	1 367	5 397	1 634
2516.90	Monumental or building stone, n.e.s.	9 034	1 608	5 592	1 342	5 918	1 832
2517.10	Pebbles, gravel, broken or crushed stone used for aggregates, etc.	3 325 867	16 616	3 293 202	17 386	3 240 164	18 985
2517.41	Marble granules, chipping and powder of 25.15 or 25.16, heat-treated or not	68 470	9 729	79 104	12 715	104 178	17 170
2517.49	Granules, chippings and powder, n.e.s. of 25.15 or 25.16, heat-treated or not	215 304	2 952	77 997	1 986	40 576	1 744
6801.00	Setts, curbstones and flagstones of natural stone (except slate)	. .	472	. .	692	. .	631
6802.10	Tiles, etc., rectangular or square not more than 7 cm, etc., artificially coloured granules, chippings and powder	. .	319	. .	275	. .	587
6802.21	Monumental or building stone, cut or sawn, flat or even, marble, travertine and alabaster	. .	6 323	. .	7 675	. .	9 390
6802.22	Monumental or building stone, cut or sawn, flat or even, other calcareous stone	. .	354	. .	238	. .	176
6802.23.10	Granite, cut or sawn flat or even, building stone	1 877	2 011	2 200	2 948	2 901	4 109
6802.23.20	Granite, cut or sawn flat or even, monumental	347	526	451	554	652	577
6802.23.90	Granite, cut or sawn flat or even, granite other	5 388	6 160	4 527	6 193	6 065	9 321
6802.29	Monumental or building stone, cut or sawn, flat or even, n.e.s.	. .	312	. .	497	. .	786
6802.91	Worked monumental or building stone, n.e.s., marble, travertine or alabaster	. .	14 320	. .	16 137	. .	19 374
6802.92	Worked monumental or building stone, n.e.s., calcareous stone, n.e.s.	. .	602	. .	1 398	. .	1 551
6802.93.10	Worked building stone of granite	1 718	2 520	1 406	2 150	1 876	3 458
6802.93.20	Worked monumental stone of granite, monuments, bases and markets finished	971	1 110	993	1 219	1 925	2 725
6802.93.90	Worked monumental or building stone, n.e.s., granite	4 940	7 299	4 311	6 538	4 530	8 181
6802.99	Worked monumental or building stone, n.e.s.	. .	1 519	. .	2 792	. .	2 460
6803.00	Worked slate and articles of slate or agglomerated slate	. .	4 764	. .	7 442	. .	7 794
6804.10	Millstones and grindstones for milling, grinding or pulping	. .	1 976	. .	1 859	. .	2 449
6804.23	Millstones, grindstones, etc., of natural stone	. .	1 574	. .	859	. .	1 003

Source: Statistics Canada.
. . Not available or not applicable; n.e.s. Not elsewhere specified; p Preliminary.

TABLE 2. CANADA, TOTAL PRODUCTION OF STONE, 1996-98

	1996		1997		1998p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
BY PROVINCE[1]						
Newfoundland	1 652r	15 442r	2 336	20 974	2 056	17 361
Nova Scotia	6 260	35 726	7 764	45 523	5 768	34 556
New Brunswick	4 691	23 539	3 934	20 293	3 175	19 256
Quebec	30 008r	188 855r	29 043	187 544	28 609	192 871
Ontario	39 620	267 710	44 839	299 792	45 304	307 677
Manitoba	3 298	14 422	4 249	18 718	4 181	19 983
Alberta	549	6 174	591	6 698	537	6 274
British Columbia	6 050	39 483	6 266	43 497	6 125	47 086
Northwest Territories and Yukon	203	1 195	243	1 123	244	1 132
Total	92 331r	592 547r	99 265	644 162	95 998	646 198
BY USE[2]						
Dimensional stone						
Rough	232	28 853	285	30 799	. .	. .
Monumental and ornamental stone (n.f.)	53	7 111	54	6 356	. .	. .
Other (flagstone, curbstone, paving blocks, etc.)	39	3 327	54	6 186	. .	. .
Lining open-hearth furnaces	–	–	–	–	. .	. .
Chemical and metallurgical						
Cement plants, Canada	14 390	44 589	14 731	45 065	. .	. .
Cement plants, foreign	1 725	7 477	1 747	8 234	. .	. .
Flux in iron and steel furnaces	297	2 178	332	2 154	. .	. .
Flux in nonferrous smelters	164	915	158	1 046	. .	. .
Glass factories	146	2 700	181	2 850	. .	. .
Lime plants, Canada	4 828	27 045	4 285	26 276	. .	. .
Lime plants, foreign	115	700	447	2 503	. .	. .
Pulp and paper mills	134	1 558	117	1 216	. .	. .
Sugar refineries	16	68	–	1	. .	. .
Other chemical uses	1 570	9 638	1 902	11 854	. .	. .
Pulverized stone						
Whiting	40	2 879	44	3 250	. .	. .
Asphalt filler	139	198	164	226	. .	. .
Dusting coal mines	4	233	4	286	. .	. .
Agricultural purposes and fertilizer plants	946	15 545	1 078	15 617	. .	. .
Other uses	847	26 949	875	32 838	. .	. .
Miscellaneous stone						
Manufacture of artificial stone	465	2 182	8	291	. .	. .
Roofing granules	487	22 609	450	21 290	. .	. .
Poultry grit	133	1 595	167	1 848	. .	. .
Stucco dash	19	3 201	20	2 355	. .	. .
Terrazzo chips	4	365	4	179	. .	. .
Rock wool	4	29	34	571	. .	. .
Rubble and riprap	1 163	6 057	693	3 032	. .	. .
Other uses	1 416	11 443	1 869	16 489	. .	. .
Crushed stone for						
Concrete aggregate	9 803	56 521	12 631	72 511	. .	. .
Asphalt aggregate	10 681	60 754	12 559	75 803	. .	. .
Road metal	36 480	189 602	35 137	180 657	. .	. .
Railroad ballast (includes traprock)	1 393	11 090	1 563	13 783	. .	. .
Other uses	24 675	119 843	27 674	133 230	. .	. .
Total	112 409	667 254	119 267	718 792	. .	. .

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; n.f. Not finished or dressed; p Preliminary.
1 Data exclude stone used in the Canadian cement and lime industries. 2 Data include stone used in the Canadian cement and lime industries.
Note: Numbers may not add to totals due to rounding.

TABLE 3. CANADA, PRODUCTION OF LIMESTONE, 1996-98

	1996		1997		1998p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
BY PROVINCE[1]						
Newfoundland	1 066	6 950	1 660	12 542	1 813	13 204
Nova Scotia	189	3 707	253	4 797	186	3 412
New Brunswick	490	6 568	467	6 830	518	7 980
Quebec	20 997	112 106	20 633	111 452	19 939	111 066
Ontario	37 805	213 842	42 515	240 206	42 587	245 747
Manitoba	2 846	11 315	3 867	15 487	3 520	13 984
Alberta	503	5 429	535	5 631	492	5 231
British Columbia	2 960	21 094	2 843	21 854	2 561	24 211
Northwest Territories and Yukon	18	50	109	523	109	526
Total	66 875	381 059	72 882	419 322	71 726	425 359
BY USE[2]						
Dimensional stone						
Rough	50	2 371	87	3 766	. .	. .
Monumental and ornamental stone (n.f.)	7	521	13	577	. .	. .
Other (flagstone, curbstone, paving blocks, etc.)	28	2 567	37	3 008	. .	. .
Lining, open-hearth furnaces	–	–	–	–	. .	. .
Chemical and metallurgical						
Cement plants, Canada	14 127	43 856	14 417	44 219	. .	. .
Cement plants, foreign	1 725	7 477	1 747	8 234	. .	. .
Flux in iron and steel furnaces	297	2 178	332	2 154	. .	. .
Flux in nonferrous smelters	164	915	158	1 046	. .	. .
Glass factories	146	2 700	181	2 850	. .	. .
Lime plants, Canada	4 828	27 045	4 285	26 276	. .	. .
Lime plants, foreign	115	700	447	2 503	. .	. .
Pulp and paper mills	134	1 558	117	1 216	. .	. .
Sugar refineries	16	68	. . .	1	. .	. .
Other chemical uses	711	6 564	915	8 564	. .	. .
Pulverized stone						
Whiting	40	2 879	44	3 250	. .	. .
Asphalt filler	36	140	54	164	. .	. .
Dusting, coal mines	4	233	4	286	. .	. .
Agricultural purposes and fertilizer plants	942	15 463	1 071	15 475	. .	. .
Other uses	162	3 847	162	4 051	. .	. .
Miscellaneous stone						
Manufacture of artificial stone	461	2 095	–	–	. .	. .
Roofing granules	117	898	124	987	. .	. .
Poultry grit	132	1 488	166	1 754	. .	. .
Stucco dash	18	3 158	20	2 301	. .	. .
Rock wool	4	29	5	42	. .	. .
Rubble and riprap	601	3 898	287	1 469	. .	. .
Other uses	1 196	10 316	1 579	15 117	. .	. .
Crushed stone for						
Concrete aggregate	7 552	42 657	9 442	52 803	. .	. .
Asphalt aggregate	5 845	30 027	7 466	44 003	. .	. .
Road metal	28 554	150 707	29 039	150 024	. .	. .
Railroad ballast	133	745	205	1 573	. .	. .
Other uses	17 687	84 860	19 180	92 106	. .	. .
Total	85 830	451 959	91 583	489 817	. .	. .

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed; n.f. Not finished or dressed; p Preliminary.
[1] Data exclude stone used in the Canadian cement and lime industries. [2] Data include stone used in the Canadian cement and lime industries.
Note: Numbers may not add to totals due to rounding.

TABLE 4. CANADA, PRODUCTION OF MARBLE,[1] 1996-98

	1996		1997		1998p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
BY PROVINCE						
Quebec	502	9 844	477	10 860	570	12 948
Ontario	416	17 909	458	22 229	553	19 153
British Columbia	–	–	7	132	–	–
Total	918	27 753	941	33 222	1 123	32 101
BY USE						
Dimensional stone						
Rough	14	1 003	23	1 013	. .	. .
Monumental and ornamental stone (n.f.)	–	–	–	–	. .	. .
Other (flagstone, curbstone, paving, blocks, etc.)	–	–	–	–	. .	. .
Chemical process stone						
Glass factories	–	–	–	–	. .	. .
Pulverized stone						
Agricultural purposes and fertilizer plants	4	82	8	143	. .	. .
Other uses	499	21 958	535	27 723	. .	. .
Miscellaneous stone						
Artificial stone	–	–	2	44	. .	. .
Roofing granules	–	–	–	–	. .	. .
Poultry grit	. . .	5	. . .	3	. .	. .
Stucco dash	–	–	1	31	. .	. .
Terrazzo chips	4	365	4	179	. .	. .
Rock wool	–	–	1	14		
Rubble and riprap	. . .	9	–	–	. .	. .
Other uses	13	642	23	769	. .	. .
Crushed stone for						
Concrete aggregate	140	1 603	150	1 697	. .	. .
Asphalt aggregate	51	307	20	114	. .	. .
Road metal	47	285	29	188	. .	. .
Other uses	145	1 495	145	1 305	. .	. .
Total	918	27 753	941	33 222	. .	. .

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed; n.f. Not finished or dressed; p Preliminary.
[1] Marble refers to a commercial definition that may also include limestone, travertine and greenstone (serpentinite or amphibole).
Note: Numbers may not add to totals due to rounding.

TABLE 5. CANADA, PRODUCTION OF GRANITE, 1996-98

	1996		1997		1998p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
BY PROVINCE						
Newfoundland	487	4 975	222	4 433	53	3 406
Nova Scotia	4 963	25 866	6 152	33 473	4 355	23 667
New Brunswick	4 137	16 623	3 424	13 324	2 596	10 947
Quebec	6 283	52 534	5 982	49 988	6 384	53 873
Ontario	1 390	34 565	1 855	35 987	2 151	41 080
Manitoba	287	2 993	202	3 106	519	5 918
British Columbia	3 080	18 286	3 397	21 338	3 544	22 702
Northwest Territories and Yukon	156	1 083	79	526	79	531
Total	20 782	156 925	21 314	162 174	19 681	162 123
BY USE						
Dimensional stone						
Rough	118	17 880	120	18 687	. .	. .
Monumental and ornamental stone (n.f.)	44	6 559	40	5 689	. .	. .
Other (flagstone, curbstone, paving blocks, etc.)	1	170	1	138	. .	. .
Chemical and metallurgical						
Cement plants, Canadian	–	–	–	–	. .	. .
Pulverized stone						
Asphalt filler	103	58	111	62	. .	. .
Agricultural purposes and fertilizer plants	–	–	–	–	. .	. .
Other	46	230	15	86	. .	. .
Miscellaneous stone						
Artificial stone	–	–	3	184	. .	. .
Roofing granules	370	21 711	326	20 303	. .	. .
Poultry grit	1	102	1	91	. .	. .
Stucco dash	1	43	. . .	23	. .	. .
Terrazzo chips	–	–	–	–	. .	. .
Rock wool	–	–	27	516	. .	. .
Rubble and riprap	490	1 946	205	1 163	. .	. .
Other uses	32	322	25	212	. .	. .
Crushed stone for						
Concrete aggregate	1 944	11 402	2 842	16 945	. .	. .
Asphalt aggregate	4 182	26 802	4 735	29 693	. .	. .
Road metal	7 005	33 858	4 893	24 587	. .	. .
Railroad ballast (includes traprock)	1 215	10 169	1 315	12 055	. .	. .
Other uses	5 231	25 672	6 655	31 742	. .	. .
Total	20 782	156 925	21 314	162 174	. .	. .

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed; n.f. Not finished or dressed; p Preliminary.
Notes: Numbers may not add to totals due to rounding. Data include shipments by producers regardless of industrial classification. Granite includes all igneous rock.

TABLE 6. CANADA, PRODUCTION OF SANDSTONE, 1996-98

	1996		1997		1998p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
BY PROVINCE[1]						
Newfoundland	96	517	319	1 239	188	742
Nova Scotia	1 092	6 061	1 335	7 174	1 201	7 359
New Brunswick	. . .	29	–	–	–	–
Quebec	1 776	12 055	1 516	10 523	1 506	10 886
Ontario	8	1 395	11	1 369	13	1 698
Manitoba	–	–	1	2	1	1
Alberta	5	677	8	987	8	981
Total	2 978	20 734	3 190	21 293	2 917	21 668
BY USE[2]						
Dimensional stone						
Rough	46	4 599	53	4 915	. .	. .
Monumental and ornamental stone (n.f.)	3	30	1	91	. .	. .
Other (flagstone, curbstone, paving blocks, etc.)	10	591	9	407	. .	. .
Chemical process stone						
Cement plants, Canadian	18	84	39	166	. .	. .
Pulverized stone						
Other	141	914	163	978	. .	. .
Miscellaneous stone						
Artificial stone	4	87	3	63	. .	. .
Roofing granules	–	–	. .	. .	. .	. .
Rubble and riprap	41	128	133	291	. .	. .
Other	10	49	52	186	. .	. .
Crushed stone for						
Concrete aggregate	164	838	197	1 067	. .	. .
Asphalt aggregate	511	3 202	245	1 613	. .	. .
Road metal	679	3 653	968	4 836	. .	. .
Railroad ballast	45	177	42	155	. .	. .
Other uses	1 323	6 468	1 323	6 691	. .	. .
Total	2 996	20 819	3 228	21 459	. .	. .

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed; n.f. Not finished or dressed; p Preliminary.
[1] Data exclude stone used in the Canadian cement industry. [2] Data include stone used in the Canadian cement industry.
Note: Numbers may not add to totals due to rounding.

TABLE 7. CANADA, PRODUCTION OF SHALE,[1] 1996-98

	1996		1997		1998p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
BY PROVINCE[2]						
Newfoundland	3	3 000	135	2 760	2	11
Nova Scotia	16	93	23	78	26	118
New Brunswick	64	320	42	140	60	330
Quebec	449	2 316	435	4 720	210	4 098
Manitoba	165	114	180	123	142	80
Alberta	41	69	48	81	37	63
British Columbia	11	103	19	174	19	174
Northwest Territories and Yukon	28	62	55	75	55	75
Total	778	6 076	938	8 151	552	4 948
BY USE[3]						
Dimensional stone						
Rough	3	3 000	2	2 418	. .	. .
Other (flagstone, curbstone, paving blocks, etc.)	–	–	7	2 632	. .	. .
Chemical and metallurgical						
Cement plants, Canadian	245	649	275	680	. .	. .
Other chemical uses	859	3 074	987	3 289	. .	. .
Miscellaneous stone						
Roofing granules	–	–	–	–	. .	. .
Rubble and riprap	31	76	68	108	. .	. .
Other uses	165	114	191	205	. .	. .
Crushed stone for						
Concrete aggregate	3	21	–	–	. .	. .
Asphalt aggregate	93	417	92	380	. .	. .
Road metal	194	1 099	208	1 022	. .	. .
Railway ballast	–	–	–	–	. .	. .
Other uses	289	1 349	370	1 385	. .	. .
Total	1 882	9 798	2 200	12 119	. .	. .

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; p Preliminary.
[1] May include slate. [2] Data exclude stone used in the Canadian cement industry. [3] Data include stone used in the Canadian cement industry.
Note: Numbers may not add to totals due to rounding.

TABLE 8. CANADA, PRODUCTION OF STONE BY TYPES,[1] 1985, 1990 AND 1996-98

	1985		1990		1996		1997		1998p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Granite	17 219	95 424	19 524	147 048	20 782	156 925	21 314	162 174	19 681	162 123
Limestone	77 874	317 862	86 519	470 649	66 875r	381 059r	72 882	419 322	71 726	425 359
Marble	571	13 966	771	19 555	918	27 753	941	33 222	1 123	32 101
Sandstone	3 011	15 310	2 975	20 534	2 978	20 734	3 190	21 293	2 917	21 668
Shale[2]	1 561	3 059	1 566	5 169	778	6 076	938	8 151	552	4 948
Total	100 236	445 622	111 355	663 254	92 331r	592 547r	99 265	644 162	95 998	646 198

Sources: Natural Resources Canada; Statistics Canada.
p Preliminary.
[1] Data exclude stone used in the Canadian cement and lime industries. [2] May include slate.
Note: Numbers may not add to totals due to rounding.

TABLE 9. CANADA, ROUGH GRANITE, SUMMARY OF PRODUCTION AND TRADE, 1980 AND 1985-98

	Quantity / Value	Production[1]	Imports[2]	Exports[2]
1980	t	81 000	24 130	5 019[a]
	$ millions	5.6	1.9	0.7
1985	t	104 000	34 468	12 511[a]
	$ millions	12.8	6.2	1.7
1986	t	121 000	33 994	18 450[a]
	$ millions	15.7	6.6	2.7
1987	t	112 000	46 370	37 450[a]
	$ millions	16.1	7.9	6.0
1988	t	153 000	46 282	86 940
	$ millions	24.4	11.2	16.2[r]
1989	t	162 000	52 337	107 105
	$ millions	24.8	11.7	17.3
1990	t	166 000	46 149	79 640[r]
	$ millions	33.6	11.2	19.8[r]
1991	t	122 000	35 038	91 630[r]
	$ millions	24.0	8.5	22.6
1992	t	127 000	44 951	94 530[r]
	$ millions	20.3	10.5	21.4
1993	t	134 000	41 484	88 830[r]
	$ millions	18.1	10.8	20.3
1994	t	112 000	35 619	95 000[r]
	$ millions	16.9	10.1	20.0
1995	t	158 000	41 099	94 200[r]
	$ millions	19.6	11.4	17.9
1996	t	163 000	53 543	97 700[r]
	$ millions	24.6	15.4	20.9
1997	t	161 000	54 639	80 194[r]
	$ millions	24.5	16.0	16.4
1998	t	145 000[e]	75 186	69 462
	$ millions	22.1	23.0	14.7

Sources: Natural Resources Canada; Statistics Canada.
[e] Estimated; [r] Assumes a factor of 2.7 for converting cubic metres to tonnes.
[a] Coded as building stone, rough (90% is considered to be granite).
[1] Includes rough stone for construction, monumental/ornamental and other uses.
[2] Includes codes 2516.11 (roughly trimmed block) and 2516.12 (cut block by sawing or otherwise). Some re-exports to the United States may also be involved.

Sulphur

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As with last year's review, this review on sulphur has been abbreviated to include mainly statistical tables.

Preliminary figures for 1998 show Canadian sulphur production was up by 2.2% when compared to the previous year's level. Total sulphur production was estimated at 9.7 Mt. Of this amount, elemental sulphur accounted for 8.5 Mt. Nearly all of this came from the production of natural gas, with the remainder derived from the refining of high-sulphur crude oil and heavy oil. An additional 1.2 Mt of sulphur, in the form of sulphuric acid and liquefied sulphur dioxide, was recovered from the smelting of metallic sulphides and the roasting of zinc-sulphide concentrates. Most sulphur production occurs in Alberta, followed by British Columbia and Saskatchewan. Other provinces produce small amounts of sulphur.

At an estimated 5.2 Mt, Canadian sulphur offshore exports[1] in 1998 were about 7% lower than in 1997. This decrease was mostly due to much reduced exports to Brazil and Morocco, the largest offshore destinations for Canadian sulphur. Some of this reduction was offset by a significant increase in exports to China. Canadian sulphur was sold to more than 20 countries.

In addition, Canada exported 1.8 Mt of sulphuric acid, nearly all of it to the United States, as well as a small amount of sulphur dioxide, all of which went to the United States. Canadian sulphur imports continued to be minimal and were mostly from the United States.

Most elemental sulphur is consumed in the form of sulphuric acid, for which the single largest use is in the manufacture of phosphate-based fertilizers. An estimated 2.5 Mt of sulphuric acid were consumed in Canada in 1997 (an amount similar to that in 1996), the latest year for which statistics are available. About half of the acid consumption was for agricultural chemicals and fertilizers. The next largest use was for the pulp and paper industry followed closely by the industrial inorganic chemicals, which have shown a marked increase compared to 1996.

Of importance to the Canadian sulphur industry is the revocation by the U.S. International Trade Commission (ITC) of the antidumping duty order on elemental sulphur from Canada. In its "sunset" review, the ITC found that lifting existing duties would not hurt the U.S. industry. As a result, duties will be lifted on January 1, 2000. This review was also prompted by the U.S. obligations under the *Uruguay Round Agreements Act* to revoke countervailing or antidumping duties after five years unless injury can be demonstrated.

Prices

Entering 1998, sulphur price quotations on a free on board (f.o.b.) Vancouver basis were between US$38 and $30/t. Quotations decreased consistently through the beginning of the year to reach a low of US$21-$23/t in June. Quotations then remained at that level for the rest of the year. Prices could have fallen lower if several major suppliers had not initiated inventory additions.

Uses

The principal use of all sulphur consumed in the world is as a process agent in the manufacture of fertilizers such as superphosphates, ammonium phosphate, and ammonium sulphate (60% of world demand). The second largest consuming sector is the chemicals industry where sulphur is used as sulphuric acid in products ranging from pharmaceuticals to synthetic fibres. Other consumers of sulphur include manufacturers of pulp and paper, iron and steel, nonferrous metals, and titanium dioxide pigments. These consuming industries use sulphur in the form of sulphuric acid, which accounts for almost

[1] The trade numbers used are from industry, which differ from Statistics Canada's numbers.

90% of total sulphur consumption. (Some 60% of sulphuric acid consumption is in fertilizers.) Manufactured products that require sulphur in non-acid form in their production include insecticides and fungicides, pulp and paper, photography, leather products, rayon and rubber.

OUTLOOK

In 1999, the world sulphur market is expected to perform at a level equal to or slightly better than that of 1998. The consumption of phosphate fertilizers is forecast to grow in most Asian regions where the average economic growth has been evaluated by the World Bank at 5.7% for the next decade. The commitment by Chinese authorities to meet the pressing needs of the agricultural sector has already generated a series of investments in phosphate-based fertilizers. Furthermore, the commitment of the Chinese government to move away from the pyrite process for sulphur production has already had a significant positive impact on Canadian exports, which are expected to do even better in 1999. China's output from its chemical fertilizer industry is expected to reach 32 Mt in 2000, up 7 Mt from its 1995 performance. In India, the government has delivered on its promise to increase access to fertilizers by readjusting its subsidies and pricing mechanisms for phosphate fertilizers. As a result, yearly sulphur imports by India are expected to reach 2.7 Mt in 2005 from its current level of 1.8 Mt.

In 1999, Canadian production is expected to remain at its 1998 level or to be up marginally; however, prices are expected to rebound throughout all of 1999.

Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of March 31, 1999.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2503.00.00	Sulphur of all kinds, other than sublimed sulphur, precipitated sulphur and colloidal sulphur				
2503.00.00.10	Crude or unrefined sulphur	Free	Free	Free	Free
2503.00.00.90	Other	Free	Free	Free	Free
2802.00.00	Sulphur, sublimed or precipitated; colloidal sulphur	Free	Free	Free	Free
2807.00.00	Sulphuric acid; oleum	Free	Free	Free	Free
2811.23.00	Sulphur dioxide	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999.

TABLE 1. CANADA, SULPHUR SHIPMENTS AND TRADE, 1997 AND 1998

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
SHIPMENTS[1]					
	Sulphur in smelter gases[2]	1 060 743r	78 831r	1 114 717	77 592
	Elemental sulphur[3]	7 900 926r	82 846r	7 307 471	49 357
	Total sulphur content	8 961 669r	161 677r	8 422 188	126 949
PRODUCTION					
	Sulphur in smelter gases[2]	1 073 128r	. .	1 152 922	. .
	Elemental sulphur[3]	8 407 686r	. .	8 544 544	. .
	Total sulphur content[2]	9 480 814r	. .	9 697 466	. .
IMPORTS					
2503.00.00.10	Sulphur, crude or unrefined				
	United States	15 791	2 305	23 374	3 451
	China	–	–	2	. . .
	Total	15 791	2 305	23 376	3 451
2503.00.00.90	Sulphur, n.e.s.				
	United States	28 732	4 351	27 471	4 746
	France	1 813r	311r	322	48
	Finland	–	–	154	22
	Germany	–	–	38	7
	Malaysia	–	–	5	1
	Japan	2	. . .	2	. . .
	Uruguay	–	–	1	. . .
	Other countries	32	4	–	–
	Total	30 579r	4 666r	27 993	4 824
2802.00	Sulphur sublimed or precipitated; colloidal sulphur				
	France	156r	95r	901	280
	United States	305r	150r	288	126
	Japan	21	12	11	7
	Germany	10r	5r	3	2
	Netherlands	1	1	3	2
	Spain	7	5	–	–
	Total	500r	268r	1 206	417
2807.00	Sulphuric acid; oleum				
	United States	95 109r	7 480r	128 799	9 592
	India	338	44	181	31
	Canada	87	4	51	6
	Norway	–	–	17	2
	United Kingdom	–	–	6	1
	Germany	3	. . .	13	1
	South Africa	–	–	40	1
	Other countries	14	1	8	–
	Total	95 551r	7 529r	129 115	9 634
2811.23	Sulphur dioxide				
	United States	3 270r	606r	2 090	239
	Germany	–	–	73	9
	Canada	42	9	–	–
	United Kingdom	3	1	–	–
	Total	3 315r	616r	2 163	248

TABLE 1 (cont'd)

Item No.		1997		1998p	
		(tonnes)	($000)	(tonnes)	($000)
EXPORTS					
2503.00.00.10	Sulphur, crude or unrefined				
	Morocco	1 255 263r	93 982r	753 279	45 115
	Brazil	970 380r	66 171r	711 834	42 069
	United States	943 824	33 813r	652 222	27 562
	South Africa	632 272r	32 248r	570 212	25 670
	Mexico	503 957r	23 858r	384 558	16 423
	Israel	301 281	12 908	418 910	16 292
	China	174 958	8 281	405 894	15 502
	Cuba	130 445	15 601	163 406	14 700
	Tunisia	459 209	25 829	256 016	12 364
	Australia	107 512	4 440	181 165	7 204
	Indonesia	118 232r	7 385	132 399	7 147
	Thailand	33 583	2 354	95 233	6 523
	Senegal	–	–	115 268	4 209
	New Zealand	190 688r	9 219r	79 450	3 300
	India	157 853	7 609	58 564	1 702
	Argentina	94 336r	5 377r	24 332	1641
	Egypt	27 523	1 441	32 340	1 349
	Vietnam	21 000	1 093	21 000	1 058
	Philippines	133 563	7 517	20 004	998
	Chile	35 970	2 984	12 549	980
	South Korea	38 523	2 050	–	–
	Jordan	32 304	1 393	–	–
	Italy	20 788	1 611	–	–
	Nigeria	9 847	504	–	–
	Malaysia	9 343	405	–	–
	Uganda	6 500	343	–	–
	Uruguay	4 950	277	–	–
	Martinique	4 911	388	–	–
	Total	6 419 015r	369 031r	5 088 635	251 808
2503.00.00.90	Sulphur, n.e.s.				
	United States	76 929r	5 018r	53 335	4 871
	New Zealand	647r	117r	–	–
	Mexico	1 162r	145r	–	–
	Total	78 738r	5 280r	53 335	4 871
2802.00	Sulphur, sublimed or precipitated; colloidal sulphur				
	United States	1 423	213	2 017	254
	China	–	–	1 980	86
	France	28	106	–	–
	Total	1 451	319	3 997	340
2807.00	Sulphuric acid; oleum				
	United States	1 588 405	71 276	1 566 699	80 226
	Mexico	–	–	28 954	1 243
	Chile	–	–	9	22
	Italy	–	–	53	8
	Georgia	14 005	164	–	–
	Pakistan	12	51	–	–
	Nicaragua	39	32	–	–
	Saint Lucia	4	12	–	–
	Cuba	3	11	–	–
	Total	1 602 468	71 546	1 595 715	81 499
2811.23	Sulphur dioxide				
	United States	77 445	19 936	57 581	16 373
	Total	77 445	19 936	57 581	16 373

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified; p Preliminary; r Revised.
[1] Data compiled regardless of origin (i.e., domestic and foreign source materials). [2] Sulphur in liquefied SO_2 and H_2SO_4 recovered from the smelting of metallic sulphides and from the roasting of zinc-sulphide concentrates. [3] Producers' shipments of elemental sulphur produced from natural gas; also included are small quantities of sulphur produced in the refining of domestic crude oil and synthetic crude oil.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, SULPHUR SHIPMENTS AND TRADE, 1983-98

	Shipments[1]			Imports[2]	Exports[2]
	In Smelter Gases	Elemental Sulphur	Total	Elemental Sulphur	Elemental Sulphur
			(tonnes)		
1983	678 286	6 631 123	7 309 409	2 365	5 670 275
1984	844 276	8 352 978	9 197 254	3 019	7 326 847
1985	822 359	8 102 163	8 924 522	3 167	7 848 380
1986	758 141	6 953 298	7 711 439	10 763	6 257 054
1987	783 115	7 322 791	8 105 906	24 711	6 571 800
1988	867 800	8 106 641	8 974 441	21 825	7 384 160
1989	831 503	6 868 930	7 700 433	18 311	5 514 059
1990	879 149	6 873 495	7 752 644	13 203	6 057 523
1991	883 565	6 937 884	7 821 449	9 026	5 845 372
1992	914 978	6 393 932	7 308 910	8 645	5 653 506
1993	856 236	5 220 304	6 076 540	7 532	4 193 877
1994	1 025 561	5 791 482	6 817 043	1 979	4 983 257
1995	1 074 206	7 089 297	8 163 503	25 593	6 077 414
1996	1 033 348	7 433 112	8 466 460	24 345	6 026 287
1997	1 060 743	7 900 926	8 961 669	46 370	6 497 753
1998p	1 114 717	7 307 471	8 422 188	32 817	5 141 970

Sources: Natural Resources Canada; Statistics Canada.
p Preliminary.
1 Shipment data compiled regardless of origin (i.e., domestic and foreign source materials). 2 Includes only elemental sulphur in a crude or refined form.

TABLE 3. CANADA, SULPHURIC ACID PRODUCTION, TRADE AND APPARENT CONSUMPTION, 1986-98

	Production	Imports	Exports	Apparent Consumption
		(tonnes, 100% acid)		
1986	3 536 062	29 127	755 606	2 809 583
1987	3 436 977	44 623	803 178	2 678 422
1988	3 804 856	40 078	851 622	2 993 312
1989	3 718 578	28 433	978 190	2 768 821
1990	3 829 570	71319	1 280 502	2 620 387
1991	3 675 839	79 207	1 265 740	2 489 306
1992	3 776 086	86 284	1 340 213	2 522 157
1993	3 958 416	95 806	1 629 054	2 425 168
1994	4 055 165	68 261	1 645 406	2 478 020
1995	4 276 383	70 816	1 732 522	2 614 677
1996	4 355 592	76 016	1 596 343	2 835 265
1997	4 314 773	95 551	1 602 468	2 807 856
1998p	. .	129 115	1 595 715	. .

Sources: Natural Resources Canada; Statistics Canada.
. . Not available; p Preliminary.

TABLE 4. CANADA, SULPHURIC ACID, REPORTED CONSUMPTION BY END USE, 1995-97

	1995[a]	1996[a]	1997p,[a]
		(tonnes)	
Agricultural chemicals and fertilizers	1 285 834	1 227 577	1 164 570
Pulp and paper	476 152	470 325	490 822
Industrial inorganic chemicals	369 770	388 850	459 483
Nonferrous smelting and refining	116 421	122 631	116 502
Uranium mines	118 785	108 294	102 159
Crude and refined petroleum products	64 631	58 865	54 445
Other mines, metal and nonmetal	34 149	39 478	30 160
Soap and cleaning compounds	x	x	x
Food, brewery and distillery	x	7 252	x
Metal rolling and extruding	8 026	x	9 120
Electrical products	x	x	3 577
Leather and textile	x	x	x
Plastics and synthetic resins	x	x	–
Other end uses	68 517	39 242	35 794
Total[1]	2 560 406	2 487 556	2 485 013

Source: Reports from producing companies, compiled by Natural Resources Canada, 1998.
– Nil; p Preliminary; x Confidential.
a Confidential numbers are included in the totals.
1 Reported consumption does not include imported acid.

TABLE 5. CANADA, CRUDE OIL AND OIL SANDS REFINERIES, SULPHUR CAPACITY, 1996-98

Operating Company	Location	Daily Sulphur Capacity 1996	1997	1998
			(tonnes/day)	
CRUDE OIL REFINERIES				
Canadian Ultramar Limited	St. Romuald, Quebec	50	50	50
Chevron Canada Limited	Burnaby, British Columbia	15	32	33
Imperial Oil Limited	Dartmouth, Nova Scotia	76	56	56
	Edmonton, Alberta	40	40	40
	Nanticoke, Ontario	59	70	86
	Sarnia, Ontario	140	140	140
Irving Oil Limited	Saint John, New Brunswick	183	183	183
North Atlantic Refinery Limited	Come-By-Chance, Newfoundland	150	150	150
Petro-Canada Inc.	Edmonton, Alberta	56	60	60
	Lake Ontario-Mississauga, Ontario	44	44	44
	Lake Ontario-Oakville, Ontario	40	40	40
Shell Canada Limited	Sarnia, Ontario	35	35	35
	Scotford, Alberta	14	14	14
Sulconam Inc.	Montréal, Quebec	150	150	150
Suncor Inc.	Sarnia, Ontario	50	50	50
Total effective capacity		1 102	1 114	1 131
HEAVY OIL UPGRADERS				
Consumers' Co-operative Refineries Limited	Regina, Saskatchewan	220	220	250
Husky Oil Operations Ltd.	Lloydminster, Saskatchewan	330	330	330
Total effective capacity		550	550	580
OIL SANDS PLANTS				
Suncor Inc.	Fort McMurray, Alberta	850	850	850
Syncrude Canada Ltd.	Mildred Lake, Alberta	1 255	1 255	1 255
Total effective capacity		2 105	2 105	2 105

Sources: Natural Resources Canada; company interviews, 1998.

TABLE 6. CANADA, NATURAL SOUR GAS PROCESSING PLANTS, SULPHUR CAPACITY, 1996-98

Operating Company	Source Field or Plant Location	H_2S in Raw Sour Gas	Daily Sulphur Capacity[1] 1996	1997	1998
		(%)	(tonnes/day)		
SOUR GAS, ALBERTA					
Alberta Energy Company Ltd.	Sinclair-Hythe	3	256	256.7	256.7
Alberta Energy Company Ltd.	Valhalla-Sexsmith	10	475.4	475.4	475.4
Amoco Canada Petroleum Company Ltd.	Bigstone, Fox Creek[2]	15	385	–	–
Amoco Canada Petroleum Company Ltd.	Caroline North-Garrington	0.3	10.4	10.4	10.4
Amoco Canada Petroleum Company Ltd.	Caroline South-Harmattan	0.4	8.6	8.6	8.6
Amoco Canada Petroleum Company Ltd.	Kaybob I/II-Fir	8	1 090	1 090	1 090
Amoco Canada Petroleum Company Ltd.	Windfall-Whitecourt	12	1 333	1 333	1 333
Anderson Exploration Limited	Carstairs	0.5	64.8	64.8	64.8
Canadian 88 Energy Corporation	Olds-Garrington	14	389	391	590.4
Chevron Canada Resources	Kaybob South III-Obed	8	3 557	3 557	3 561
Chevron Canada Resources	Medicine Lodge	7.5	55.9	55.9	55.9
Crestar Energy Inc.	Paddle River[2]	0.1	19.4	–	–
Dynegy Midstream Services	Mazeppa	25	577	577	577
Gulf Canada Limited	Brazeau River-Nordegg	1.7	46.5	46.5	46.5
Gulf Canada Limited	Brazeau River-Peco	1.3	110	110	110
Gulf Canada Limited	Homeglen-Rimbey	0.5	127.5	127.5	127.5
Gulf Canada Limited	Strachan	9	953	953	953
Husky Oil Ltd.	Rainbow Lake	2	142	142	142
Husky Oil Ltd.	Ram River (Ricinus)	16.5	4 572	4 572	4 572
Imperial Oil Resources Limited	Bonnie Glen	0.4	34.5	34.5	34.5
Imperial Oil Resources Limited	Quirk Creek	9	301.2	301.2	301.2
Imperial Oil Resources Limited	Redwater	3	11	11	11
Inuvialuit	Rainbow Lake	1.0	–	–	301.2
Mobil Oil Canada, Ltd.	Lone Pine Creek	13.5	162	162	162
Northstar Energy Corporation	Savannah Creek (Coleman)	12	696.4	696.4	789.4
Penn West Petroleum Ltd.	Minnehik-Buck Lake	0.1	45	37.5	37.5
Petro-Canada Inc.	Brazeau River-Peco	21	447.3	447.3	447.3
Petro-Canada Inc.	Hanlan Robb	8	1 092	1 092	1 095
Petro-Canada Inc.	Wildcat Hills	7	280.3	280.3	280.3
Poco Petroleums Ltd.	Sturgeon Lake South	9.5	98	98	98
PrimeWest Energy Trust Inc.	East Crossfield-Lone Pine Creek[3]	34	283	283	–
Rio Alto Exploration Ltd.	Gold Creek	2.4	43	97	97
Shell Canada Limited	Burnt Timber Creek (Cremona)	13	560	560	560
Shell Canada Limited	Caroline	25	4 504	4 504	5 445
Shell Canada Limited	Cochrane (Jumping Pound)	7.5	597	597	597
Shell Canada Limited	Pincher Creek (Waterton)	15	3 107	3 107	3 107
Suncor Inc.	Rosevear North	8	111.3	111.3	109.5
Suncor Inc.	Rosevear South	6.5	171	171	171
Suncor Inc.	Simonette River	5.5	115.8	115.8	115.8
Talisman Energy Inc.	Edson-Pine Creek	1.4	292	292	342.6
Talisman Energy Inc.	Teepee Creek	0.4	23	23	23
Talisman Energy Inc.	Turner Valley	1.2	15.5	15.5	–
TransCanada Midstream	Harmattan-Elkton-Leduc	52	66.2	81	81.5
TransCanada Midstream	Zama	4	74	74	74
Ulster Petroleums Ltd.	Wimborne	10.5	182	182	182
Union Pacific Resources Inc.	Progress	0.7	49.5	49.5	224.4
Western Facilities Management Limited	Nevis	4	245.8	300	300
Wascana Energy Inc.	East Calgary-Crossfield	16	1 696	1 696	1 696
Wolcott Gas Processing Ltd.	W. Pembina-Brazeau	11	520	520	520
SOUR GAS, BRITISH COLUMBIA					
Amoco Canada Petroleum Company Ltd.	Cypress	1.4	12.8	12.8	12.8
Petro-Canada Inc.	Boundary Lake II (sour)	**	–	–	8
TransCanada Midstream	Caribou	**	–	–	34
Westcoast Energy Inc.	Fort Nelson	2	674	674	674
Westcoast Energy Inc.	Taylor Flats-McMahon	1.6	558	558	558
Westcoast Energy Inc.	Pine River	12	2 000	2 000	2 000

Sources: Alberta Energy and Utilities Board publication, January 1999; Natural Resources Canada company survey 1997-98; Fertecon.
– Nil; ** Unknown.
[1] Maximum design capacity. [2] Closed in 1996. [3] Closed in 1998.

TABLE 7. CANADA, PRINCIPAL SULPHUR DIOXIDE AND SULPHURIC ACID PRODUCTION CAPACITIES, 1998

Operating Company	Plant Location	Feedstock	Annual Capacity		
			Liquefied SO_2	Sulphuric Acid[1]	Sulphur Equivalent[2]
			(000 tonnes/year)		
EASTERN CANADA					
CE Zinc	Valleyfield, Que.	SO_2 zinc conc.		430	140
Falconbridge Limited	Kidd Creek, Ont.	SO_2 zinc conc.		220	72
	Kidd Creek, Ont.	SO_2 copper conc.	30	470	168
	Sudbury, Ont.	SO_2 nickel conc.		355	116
Gaspé Copper Mines, Limited	Murdochville, Que.	SO_2 copper conc.		165	54
Inco Limited	Copper Cliff, Ont.	SO_2 nickel conc.	100	1 000	377
Noranda Copper Smelting and Refining	Rouyn-Noranda, Que.	SO_2 copper conc.		450	147
Noranda Mining and Exploration Inc.	Belledune, N.B.	SO_2 lead and zinc conc.		176	57
Sulco Chemicals Ltd.	Elmira, Ont.	Elem. sulphur		33	11
Subtotal			130	3 299	1 142
WESTERN CANADA[3]					
Agrium Inc.[4]	Redwater, Alta.	Elem. sulphur		910	297
Border Chemical Company Limited	Transcona, Man.	Elem. sulphur		150	49
Cameco Corporation-Rabbit Lake Operation	Rabbit Lake, Sask.	Elem. sulphur		72	24
Cameco Corporation-Key Lake Operation	Key Lake, Sask.	Elem. sulphur		72	24
Cominco Ltd.[5]	Trail, B.C.	SO_2 lead and zinc conc.	80	430	210
Hudson Bay Mining and Smelting Co.[6]	Flin Flon, Man.	SO_2 zinc conc.		n.a.	35
Sherritt International Corporation	Fort Saskatchewan, Alta.	Elem. sulphur		233	76
Westcoast Energy Inc.	Prince George, B.C.	Elem. sulphur	30	75	39
Subtotal			110	1 942	754
Total Canada			240	5 241	1 896

Sources: Natural Resources Canada; Canadian company interviews, 1998.
n.a. Not applicable.
[1] 100% H_2SO_4. [2] Elemental sulphur equivalent of sulphuric acid is 32.7% and sulphur equivalent of liquefied SO_2 is 50%. [3] Marsulex Inc. idled its 160 000-t/y acid plant in Fort Saskatchewan in 1993. [4] Agrium Inc. acquired the acid operations from Viridian Inc. (formerly Sherritt Inc.) in 1996. [5] Cominco operation at Trail also has a 30 000-t/y production capacity for elemental sulphur that has been added to the total sulphur equivalent production capacity of Cominco. [6] Hudson Bay recovers elemental sulphur from its zinc pressure leach smelter at Flin Flon; elemental sulphur is currently disposed of in tailings.

TABLE 8. WORLD PRODUCTION OF SULPHUR, 1995-97

	1995r		1996		1997p	
	All Forms[1]	Elemental	All Forms[1]	Elemental	All Forms[1]	Elemental
			(000 tonnes)			
WESTERN EUROPE						
Finland	691	38	775	40	728	40
France	1 252	1 042	1 172	958	1 126	910
Germany	2 322	1 562	2 368	1 591	2 443	1 623
Italy	460	310	471	308	518	355
Netherlands	475	353	487	377	481	370
Spain	852	154	1 073	167	1 104	175
Others	1 103	626	1 188	702	1 200	706
Total, Western Europe	7 155	4 085	7 534	4 143	7 600	4 179
CENTRAL EUROPE						
Poland	2 635	2 425	2 002	1 790	1 935	1 710
Others	614	190	711	210	705	215
Total, Central Europe	3 249	2 615	2 713	2 000	2 640	1 925
COMMONWEALTH OF INDEPENDENT STATES	5 268	3 754	5 341	3 769	5 783	4 483
AFRICA						
South Africa	508	233	564	260	531	250
Others	179	3	167	3	182	5
Total, Africa	687	236	731	263	713	255
NORTH AMERICA						
Canada	8 953	7 973	9 412	8 429	9 394	8 401
United States	12 793	10 359	12 931	10 360	13 224	10 510
Total, North America	21 746	18 332	22 343	18 789	22 618	18 911
LATIN AMERICA						
Mexico	1 251	882	1 303	921	1 400	941
Others	1 401	521	1 557	556	1 686	567
Total, Latin America	2 652	1 403	2 860	1 477	3 086	1 508
MIDDLE EAST						
Iran	855	855	894	894	845	845
Iraq	375	375	375	375	425	425
Kuwait	559	559	576	576	591	591
Saudi Arabia	1 720	1 720	1 730	1 730	1 690	1 690
Others	754	590	1 177	1 014	1 331	1 168
Total, Middle East	4 263	4 099	4 752	4 589	4 882	4 719
ASIA						
China	7 562	403	7 969	239	8 174	315
Japan	3 133	1 682	3 217	1 791	3 451	2 013
South Korea	580	250	760	460	927	600
Others	1 201	529	1 288	632	1 349	713
Total, Asia	12 476	2 864	13 234	3 122	13 901	3 641
OCEANIA	315	89	401	95	482	95
Total, World	57 811	37 477	59 909	38 247	61 705	39 716

Source: The British Sulphur Corporation Limited, 1998.
p Preliminary; r Revised.
1 All forms includes elemental sulphur, sulphur contained in pyrites, and contained sulphur recovered from metallurgical waste gases, mostly in the form of sulphuric acid.

Uranium

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OVERVIEW

The commercial fate of the uranium derived from dismantled Russian nuclear weapons remained unresolved throughout 1998, but by year's end there were encouraging signs suggesting that the long-sought-after transaction between the Russian Ministry of Atomic Energy (Minatom) and a consortium of Western companies might finally be concluded in 1999. Concerns about the effects of the uncontrolled release of surplus military inventories into world uranium markets will ease considerably if such an agreement is concluded.

World uranium spot prices declined almost continuously during 1998, and ultimately led to announcements that a number of mines would cut back production or cease operations, and other new mine developments would be deferred. In addition to the continued uncertainty regarding competition from military uranium, primary producers faced growing competition during the year from uranium made available to the market by the operation of enrichment plants in Russia and the United States.

Canadian uranium production in 1998 amounted to 10 925 tU, down 9% from the 1997 total. As Figure 1 shows, the world's two largest uranium-producing companies have operations in Canada. As of January 1, 1998, Canada's total "known" recoverable uranium resources were 419 000 tU, compared with 430 000 tU as of January 1, 1997. The downward adjustment of some 2.5% is roughly equivalent to the resources extracted over the year.

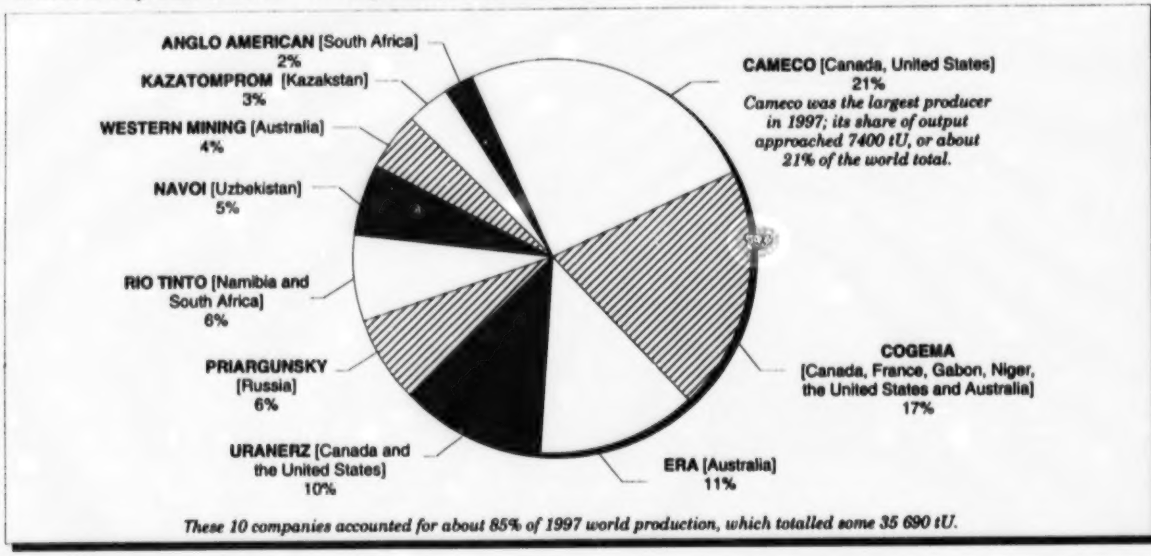
Despite poor market conditions, uranium production capability continues to increase in Canada. In April 1998, the Cigar Lake and Midwest mining projects cleared the environmental review process when government approvals to proceed were received. Construction at McClean Lake neared completion, and the mill is expected to begin production in June 1999, subject to regulatory approval. Modifications at Key Lake moved the mill closer to the configuration required to process McArthur River ore, which is scheduled to arrive late in 1999. Test mining and development work continued on schedule at Cigar Lake with the mine currently on track to open in 2001 or 2002.

DOMESTIC PRODUCTION AND DEVELOPMENTS

Primary output from Canada's three uranium-producing operations in 1998 amounted to 10 925 tU, down some 9% from 1997 production (Table 1). In 1997, overall employment at Canada's producing operations remained at just above 1100, with the losses incurred from the Stanleigh mine closure at Elliot Lake compensated for by pre-production activities at the McClean Lake and McArthur River projects in Saskatchewan. As indicated in Table 2, preliminary estimates of 1998 mine shipments, under all domestic and export contracts, decreased in tonnage and in value compared to 1997. Despite this decline, uranium continues to rank among Canada's top 10 metal commodities in terms of output value. Table 3 highlights the main operational characteristics of the existing uranium production centres in 1997, the most recent year for which complete data are available. Table 4 updates the status of new projects that represent Canada's future production capability, while Figure 2 locates Canada's producing uranium mines and major deposits and Figure 3 shows domestic production by project and owner for 1997.

In April 1998, the corporate structure of uranium mining in Canada was significantly altered when Cameco Corporation announced that it had entered into an agreement in principle to purchase Uranerz Exploration and Mining Limited and Uranerz USA Inc. from their parent company, Uranerzbergbau GmbH (UEB) of Germany. The deal was subsequently approved by anti-competition regulatory agencies in Canada, Germany and the United States

Figure 1
World's Top Ten Uranium Mining Companies in 1997



Source: Uranium Institute Pocket Guide, June 1998.
Note: Ranking reflects equity interest in production facilities, not market share.

and, on August 11, 1998, the acquisition was completed at a total cost of $489 million ($483 million plus accrued interest of $6 million). This acquisition strengthened Cameco's position as the world's largest uranium producer, increasing the company's uranium reserves, resources and uranium production levels by about 30%. The principal Canadian assets purchased by Cameco include a 33.33% interest in the Key Lake and Rabbit Lake uranium mines, a 27.92% interest in the McArthur River mine, and a 20% share in the Midwest mine. These projects are all situated in northern Saskatchewan.

The transaction also included acquisition of the 57.69% interest held by Uranerz USA Inc. in the Crow Butte uranium mine in Nebraska, as well as uranium and gold exploration properties in northern Saskatchewan and in the United States. In addition, subject to third-party consent, Cameco acquired the rights to an additional one-third interest in the Inkai uranium joint venture in Kazakstan.

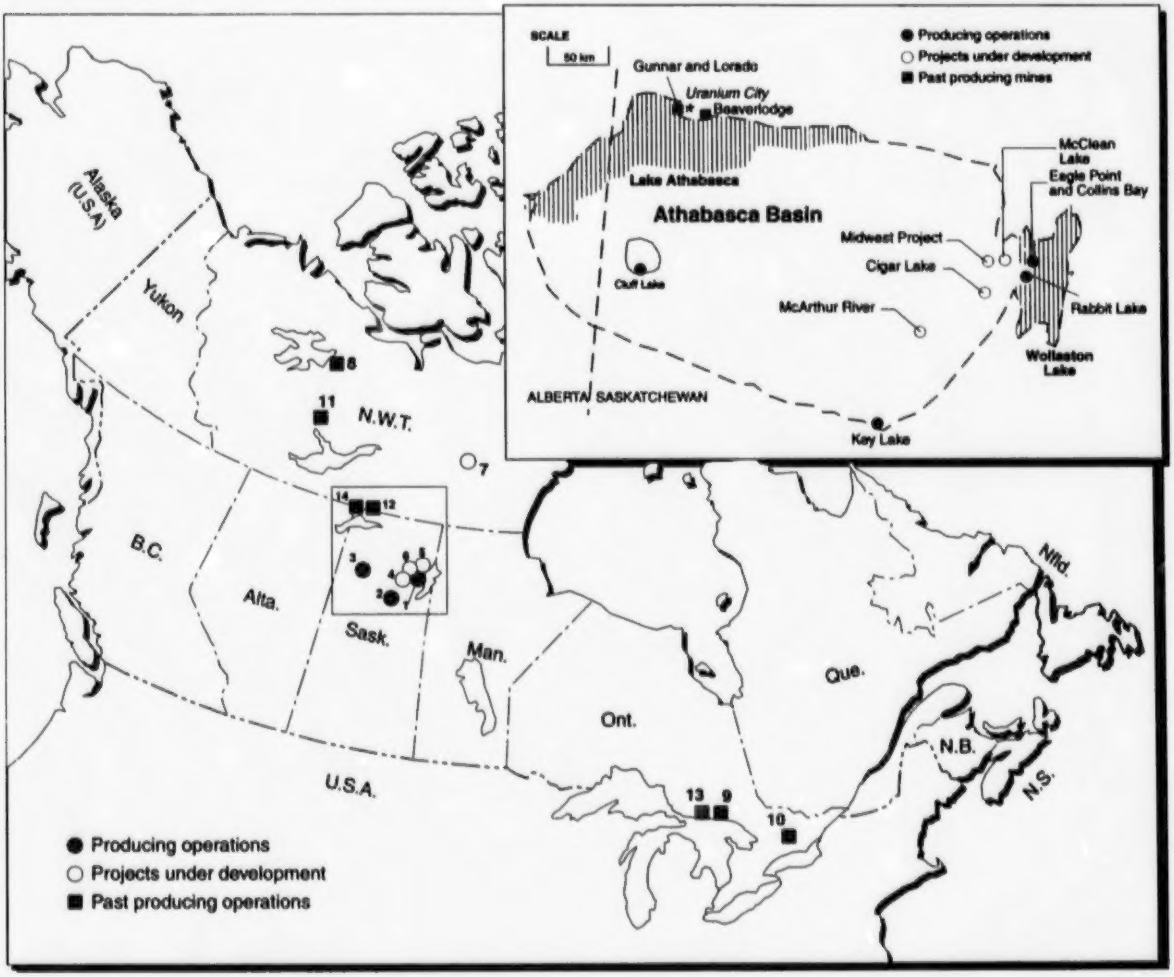
In the latter half of 1998, the declining uranium market price had an impact on Canadian operations. In August, 1998, COGEMA Resources Inc. (CRI) announced that production at Cluff Lake would be suspended indefinitely as of December 31, 2000. In January 1999, CRI moved the suspension date ahead to the summer of 2000. In November 1998, Cameco announced that in 1999 it will reduce uranium production at its Canadian operations by some 35% of 1998 production (or roughly 3800 tU). Cameco also intends to trim uranium conversion services at its Ontario operations by 10%.

Elliot Lake, Ontario

The decommissioning and rehabilitation of Denison Mines Limited's Elliot Lake properties was essentially completed in 1998 with the construction of the final dam and revegetation of the tailings surface at Stanrock. This work was conducted under the mine facility decommissioning licence for Stanrock granted by the Atomic Energy Control Board (AECB) in June 1998. The mine facility decommissioning licence for the Denison mine has not yet been amended to address all of the concerns and recommendations raised by the Federal Environmental Assessment Review Panel and government responses. Denison Mines will be seeking the necessary licence amendments in 1999. Nonetheless, both existing licences incorporate the reclamation programs presented in the Environmental Impact Statement during the environmental review.

Early in 1998, Rio Algom Limited reported that it was in full compliance for its discharges to waterways from its five closed mines at Elliot Lake (Pronto, Nordic, Quirke, Panel and Stanleigh). Significant reductions in contaminant loadings to the Serpent River watershed were documented following closure of the Stanleigh mine. At the Stanleigh waste/

Figure 2
Uranium Mining in Canada, 1998



Numbers refer to locations on map above.

PRODUCING OPERATIONS

1. Rabbit Lake (incl. Eagle Point and Collins Bay)
2. Key Lake
3. Cluff Lake

PROJECTS UNDER DEVELOPMENT

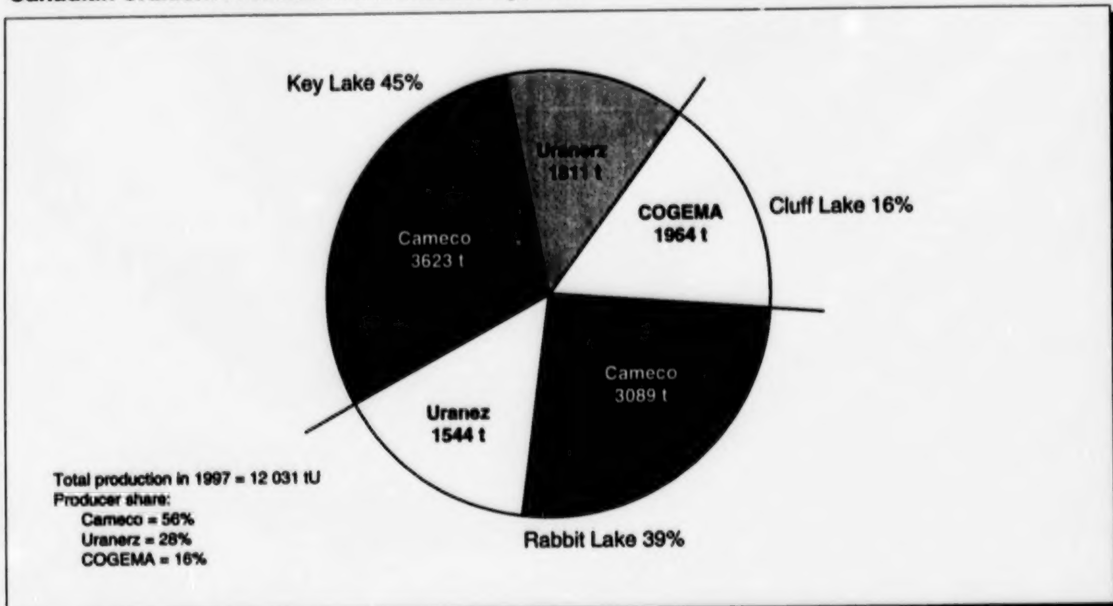
4. McArthur River
5. Midwest/McClean
6. Cigar Lake
7. Kiggavik

PAST PRODUCING DEVELOPMENT

8. Port Radium
9. Agnew Lake
10. Madawaska et al (Bancroft)
11. Rayrock (Marian River)
12. Beaverlodge et al
13. Quirke/Panel/Denison and Stanleigh et al (Elliot Lake)
14. Gunnar and Lorado et al

Source: Uranium and Radioactive Waste Division, Natural Resources Canada.

Figure 3
Canadian Uranium Production and Ownership, 1997



Source: Uranium and Radioactive Waste Division, Natural Resources Canada.

tailings management area, one existing dam was raised and construction of three new, low-permeability dams and an overflow spillway was completed in 1998. Water levels have been raised to cover the tailings and to create a water barrier to minimize acid formation and prevent airborne release of radiation. Although water levels are currently some 6 m below design levels, flooding to the final elevation is expected to take place over the next two years, depending upon precipitation rates.

Athabasca Basin, Saskatchewan

Rabbit Lake

Following the purchase of Uranerz, Cameco now fully owns and operates the Rabbit Lake uranium production facility. Rabbit Lake mill output in 1998 was about 4500 tU, down slightly from 1997 (4633 tU). Ore sources in 1998 were the Eagle Point underground mine and the Collins Bay A and B zone deposits. In October 1998, the AECB approved a two-year renewal of the Rabbit Lake mine operating licence.

Cameco's production cutbacks include the suspension of mining operations at Eagle Point at the end of March 1999. Originally, the Rabbit Lake mill was slated to close early in the next decade, but Cameco announced in November 1998 that it plans to mill a portion of the Cigar Lake ore at Rabbit Lake, extending the lifetime of the facility by some 15 years. However, until ore from the Cigar Lake mine arrives sometime in 2001 or 2002, the Rabbit Lake mill will process stockpiled ore and operate at half capacity.

Key Lake

The Key Lake uranium production facility is also fully owned and operated by Cameco following the Uranerz purchase. In 1998, production from stockpiled Deilmann ore reached 5385 tU, down slightly from 1997 (5434 tU). On November 6, 1998, the AECB amended the Key Lake operating licence to permit conversion of the Deilmann in-pit tailings management facility to the subaqueous deposition mode, and to begin construction of receiving and blending facilities to handle ore from the McArthur River mine. An extended shut-down of the Key Lake mill, beginning in July 1999, will be required to finalize construction of these facilities. Most of the remaining stockpiled ore is expected to be depleted by that time. The Key Lake mill is expected to resume production by the last quarter of 1999.

McArthur River

Cameco is also the operator of the McArthur River project, a joint venture between Cameco and CRI. On May 29, 1998, the AECB amended the McArthur

River construction licence to allow the fabrication and installation of an underground ore reclamation and milling system, and surface ore handling facilities. Construction at the McArthur River mine is on budget and on schedule, and ore production at this, the world's largest high-grade uranium deposit, is expected to begin in the last quarter of 1999.

Cigar Lake

The Cigar Lake mine, a joint venture operated by the Cigar Lake Mining Corporation (refer to Table 4), is situated on the world's second largest high-grade uranium deposit. The Cigar Lake mining project cleared the environmental review process early in 1998, and testing of mine equipment and mining techniques continued on schedule throughout the remainder of the year. The mine is scheduled to begin production in 2001 or 2002.

Cluff Lake

The Cluff Lake uranium production facility is wholly owned and operated by CRI. Mining operations were entirely underground (Dominique-Peter and Dominique-Janine West orebodies) in 1998, and overall production amounted to 1040 tU, or almost half of 1997 production. This sharp decline relates in part to the reduced rate of production required to avoid reaching full capacity in the tailings management area.

On March 26, 1998, the AECB approved a nine-month extension to the Cluff Lake operating licence, with conditions. CRI was required to:

- prepare a full report on increased radium levels detected in Snake Lake (situated next to the facility's tailings management area);
- respond to AECB questions about the safety of the operation, which included providing information demonstrating that the current radiation protection program for underground miners complies with the principle of keeping radiation levels as low as reasonably achievable (ALARA);
- submit an updated Code of Practice;
- restrict the placement of tailings in the tailings management area to specific authorized limits; and
- report to the AECB on all these issues by October 1, 1998.

On August 20, 1998, CRI announced that it would be suspending operations indefinitely at Cluff Lake on December 31, 2000. CRI indicated that the low market price of uranium could not sustain the operation in its present form, and that local reserves are insufficient to support the investment required to create the new tailings management facility (TMF) needed in 2001. However, CRI indicated that it will be conducting a vigorous exploration program in the Cluff Lake area and, if sufficient reserves are located and the market improves, it could re-open the facility.

On August 27, 1998, the AECB approved CRI's construction plan to add interim works to the tailings management facility. Construction of additional berms was required to allow the physical placement of tailings to the maximum approved capacity. CRI had originally requested approval of this plan in February 1998, but the AECB had deferred a decision pending receipt of additional information.

On December 18, 1998, the AECB granted a renewal of the Cluff Lake operating licence through to December 31, 2000, subject to two conditions. The first limited the placement of tailings to maximum elevations in the approved tailings management area (modified to include the 1998 construction areas), and the second required submission of an updated detailed decommissioning plan by June 30, 1999.

On February 2, 1999, CRI announced that it would process the remainder of the low-grade ore stockpile from the Dominique-Janine Extension open pit before suspending operations in order to avoid potential future environmental problems posed by the stockpile. To do so, the Cluff Lake mill will begin running continuously in June 1999. Continuous operation from this date will mean that full capacity in the tailings management area will be reached and operations will be suspended sometime in mid-2000.

McClean Lake

The McClean Lake uranium production facility, currently under development, is majority-owned and operated by CRI. Construction of the mill was completed late in 1997, but production has been held up until CRI obtains the necessary licencing.

On August 14, 1998, the AECB amended the McClean Lake operating licence to allow CRI to conduct specified preparatory work to convert the mined-out JEB pit for use as a TMF. On October 13, 1998, a cease-work order was issued by the AECB when it was discovered that materials used in the filter drain of the JEB TMF did not meet required specifications. This problem was resolved and, on November 19, 1998, construction resumed. However, in early December 1998, CRI stopped construction when it discovered additional problems with the filter material. By year-end, this problem had not been resolved and construction of the TMF had not resumed.

The mining of waste rock at the Sue C pit at McClean Lake was completed late in 1998. Since CRI had not secured the licencing required to begin milling the ore

and the rate of mining was progressively becoming out of step with milling, CRI announced in early January 1999 that it was laying off about 45% of the McClean Lake work force until all licencing issues were resolved. CRI anticipates having the necessary licencing in place by June 1999.

Additional Production Possibilities

Beyond the existing and committed centres of uranium production mentioned above, there are other projects that could be brought on stream in the next few years if environmental and regulatory approvals are received and market conditions are favourable. Table 4 updates, as of March 1, 1999, recent developments at the mining projects that will form the basis of Canada's uranium production capability well into the future, and indicates the current status of the environmental review process for each of them.

Saskatchewan Environmental Assessment and Review Panel

In April 1998, the governments of Canada and Saskatchewan responded to the final report issued by the Joint Federal-Provincial Panel on Uranium Mining Developments in Northern Saskatchewan. This report dealt with the Cigar Lake and Midwest projects, as well as the Joint Panel's summary of cumulative observations on the five new developments in northern Saskatchewan it had reviewed since 1991. After carefully reviewing the report, the federal and provincial governments agreed with the Joint Panel that the Cigar Lake and Midwest projects could advance to the licencing stage, subject to certain specific conditions.

The Joint Panel made 29 recommendations with a number of conditions regarding the Midwest and Cigar Lake mines. These recommendations were directed at mining techniques, disposal of tailings and waste rock, transportation of the ore, long-term environmental monitoring and biophysical impact assessment, worker health and safety, socio-economic benefits, community health and social impacts, and site decommissioning. Governments agreed with all 29 recommendations, but disagreed with two conditions attached to the recommendations.

The Joint Panel suggested that experiments be conducted to determine the long-term acceptability of the JEB TMF *prior* to tailings deposition. The Government of Canada agreed that the JEB TMF can be used, but stated that experimental studies of the aging of tailings should take place *concurrently* with disposal, indicating that laboratory experiments alone could not adequately determine the long-term acceptability of the proposed method for disposing of the tailings.

As in earlier reports, the Joint Panel suggested that a program be developed to direct a share of the uranium royalty revenues to northern municipalities and First Nations. The Government of Saskatchewan did not agree with this suggestion, indicating that this issue should be dealt with separately and apart from the environmental assessment process. Revenue-sharing is one of the topics under discussion between the Chief of the Federation of Saskatchewan Indian Nations, the Minister of Indian and Northern Affairs Canada, and the provincial Minister of Intergovernmental and Aboriginal Affairs as part of the Fiscal Relations Table Memorandum of Understanding.

In its cumulative observations, the Joint Panel made 13 comments that spanned social concerns, such as encouraging the protection of the vitality of northern communities, to technical issues, such as encouraging research on the development of more efficient and environmentally acceptable ways of processing ore and disposing of tailings. The Joint Panel urged governments to continue to support training programs for northern residents, such as the Multi-Party Training Plan, and recommended that the uranium mining companies continue to progress towards achieving targets for northern employment (67%) and northern business involvement (35%). The Joint Panel also recommended that governments and industry continue to support the existing Environmental Quality Committees that train and employ northern residents to monitor aspects of the environment that may be affected by mining and milling activities. Governments supported all of these recommendations.

The submission of this Joint Panel report brings to a close the comprehensive environmental assessment process for the five new mine developments in northern Saskatchewan. With Canada's position as the world's leading uranium producer and exporter comes the responsibility to demonstrate that its uranium producers meet a high level of health, safety and environmental standards. The federal-provincial environmental assessment process has contributed significantly to these objectives.

Other Developments Affecting Canada's Uranium Industry

On October 14, 1998, Cameco announced that it had completed an offering in the United States of US$125 million of preferred securities. Cameco stated that it will use the proceeds to replace a portion of the short-term debt financing used to acquire Uranerz Exploration and Mining Limited and Uranerz USA Inc.

EXPLORATION

Natural Resources Canada (NRCan) completed its 24th annual assessment of Canada's uranium supply capabilities and an associated survey of uranium

exploration activity, and reported[2] the results in August 1998. Uranium exploration activity remains concentrated in areas favourable for the occurrence of deposits associated with Proterozoic unconformities, notably in the Athabasca Basin of Saskatchewan and the Thelon Basin in the Northwest Territories. In 1997, overall uranium exploration expenditures reached $58 million, while uranium exploration and surface development drilling approached 104 000 m, up from about 79 000 m reported for 1996.

As in recent years, most of the increase in the overall exploration expenditures can be attributed to advanced underground exploration, deposit-appraisal activities, and care-and-maintenance expenditures associated with those Saskatchewan projects awaiting production approvals. In comparison, the Saskatchewan government estimates that grass-roots uranium exploration in the province reached $27 million in 1997, up from some $17 million in 1996. A summary of uranium exploration activity in Canada from 1982 to 1997 is provided in Table 5.

In recent years, the number of companies with major exploration programs in Canada has declined. About 40% of the 80 uranium projects maintained in good standing in 1997 were actively explored. The top five operators,[3] accounting for nearly all of the $58 million expended in 1997, were: Cameco Corporation, Cigar Lake Mining Corporation, CRI, PNC Exploration (Canada) Co. Ltd., and Uranerz Exploration and Mining Limited. Expenditures by CRI include those of Urangesellschaft Canada Limited.

Resources

NRCan's annual assessment of domestic uranium supply capability provides a compilation of Canada's "known" uranium resources, based on the results of an evaluation of company data. Uranium supply from Canada in the next decade will come from known resources, estimates of which are divided into three major categories, *measured*, *indicated* and *inferred*, that reflect different levels of confidence in the reported quantities. Most of these resources are associated with deposits identified in Figure 2.

Recent NRCan assessments of Canada's uranium resources have been restricted to those recoverable from mineable ore at prices of $150/kgU or less. Table 6 shows the breakdown of the latest resource estimates compared with those of the previous year. As of January 1, 1998, total recoverable known uranium resources were estimated at 419 000 tU, compared with 430 000 tU as of January 1, 1997. The downward adjustment of some 2.5% is roughly equivalent to 1997 Canadian uranium production.

Supply Capability

In 1998, Canada's uranium supply capability was maintained as producers were able to adjust output levels to compensate for mine closures in Ontario. Timely licensing approvals and higher uranium prices will be required to allow Canada's production capability to expand to its full potential of 20 000 tU or more annually early in the next century.

Developments in the international uranium market, the rate at which projects clear environmental reviews, and uncertainty regarding the costs associated with certain of the planned new projects preclude projecting future production capability levels with much certainty. Table 7 ranks Canada among the world's major producers, showing actual uranium production from 1993 through 1997. Figure 4 illustrates Canada's share of world output in 1997 compared with other major producers.

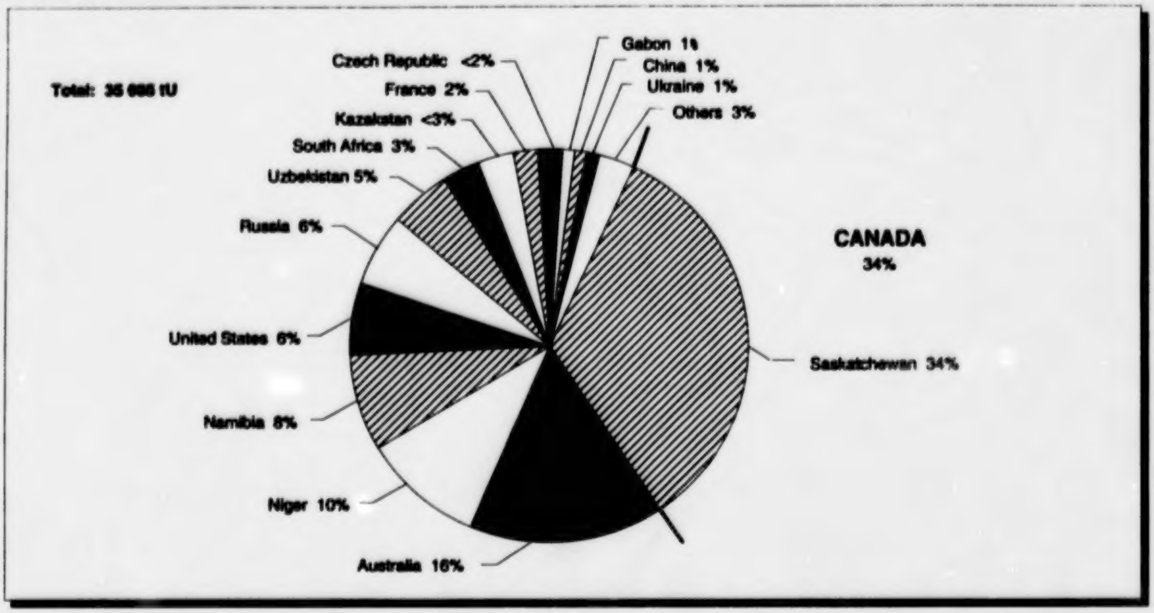
Government Initiatives

On March 20, 1997, Bill C-23, *The Nuclear Safety and Control Act* (NSCA), received Royal Assent. Proposed regulations for the NSCA were posted by the AECB for comment in July 1998. In late 1998, the AECB began consultations to address concerns raised by stakeholders regarding the new Act and associated regulations. At the same time, the AECB proceeded with the preparation of Regulatory Guidelines. It is anticipated that the NSCA will come into force in 1999.

On March 13, 1998, after almost 10 years of study and an extensive public review process, the Nuclear Fuel Waste Management and Disposal Concept Environmental Assessment Panel (also known as the Seaborn Panel) released its recommendations. The Seaborn Panel concluded that, from a technical perspective, safety of the disposal concept developed by Atomic Energy of Canada Ltd. (AECL) had been, on balance, adequately demonstrated for a conceptual stage of development but that, as it stands, the disposal concept had not been demonstrated to have broad public support. The Panel also found that the concept, in its current form, did not have the required level of acceptability to be adopted as Canada's approach for managing nuclear fuel wastes.

On December 3, 1998, the Government of Canada responded to the Seaborn Panel recommendations and laid out its objectives on the establishment of a Waste Management Organization (to be established as a separate legal entity of waste producers and owners) and federal oversight for the next steps towards the long-term management, including

Figure 4
World Uranium Production, 1997



Source: Uranium and Radioactive Waste Division, Natural Resources Canada.

disposal, of nuclear fuel waste. The Minister of Natural Resources Canada will return to Cabinet within 12 months with recommended options for federal oversight mechanisms.

On December 16, 1998, AECL announced that budgetary constraints had brought it to a decision to terminate its nuclear research activities at Whiteshell Laboratories in Pinawa, Manitoba, by December 2001. Nuclear facilities at the site will be decommissioned, but two key scientific research programs will be continued. The reactor safety research program will be consolidated at AECL's facilities at Chalk River and Sheridan Park, Ontario, and the nuclear waste management program will be privatized, following consultations with key stakeholders.

The Uranium Market

Overview

Just under half of all global uranium supply is now being met from sources other than new mine production. Yet 1998 brought announcements of several significant production cutbacks and delays of new mine development in the face of plans for further surplus government uranium to be made available to utilities. It also became apparent during the year that uranium producers are facing stiff competition from enrichers, who are re-enriching depleted uranium tails and "underfeeding" enrichment plants to create additional uranium supply. These developments were accompanied by declining uranium prices throughout the year.

At year's end, it once again appeared that a commercial transaction was imminent that would provide for the purchase by a Western consortium, over a period of several years, of much of the natural uranium being derived from Russian nuclear weapons. This uranium would then be diverted to fulfil the commitments of those companies to their own customers, reducing the quantities overhanging the market and bringing some much needed stability. It will likely be several more years before uranium prices rise sufficiently to justify the development of new production capacity.

Developments Involving Surplus Uranium from Russia and the United States

During the spring of 1998, Minatom became more receptive towards the proposal put forward by Cameco, Compagnie générale des matières nucléaires (COGEMA) of France and Nukem Inc. of Germany to purchase natural uranium derived from the dismantling of Russian nuclear weapons. With the concurrence of a Russian interministerial commission,

Minatom recommenced commercial negotiations and, on June 2, 1998, an agreement-in-principle was reached between the parties.

As the parties moved towards a formal agreement, however, the United States Enrichment Corporation (USEC) filed a registration statement with the U.S. Securities and Exchange Commission in preparation for its privatization. This statement disclosed that USEC had significantly greater inventories of uranium than had been known to the market, and that USEC planned to dispose of most of that inventory over the period 2000-05. Further, USEC planned to "underfeed" its enrichment plants in the future, thereby accumulating significant additional inventories each year that could also be sold. These revelations had an immediate impact on the market outlook, and the Western companies decided that they could not finalize a commercial agreement on the terms outlined in the agreement-in-principle.

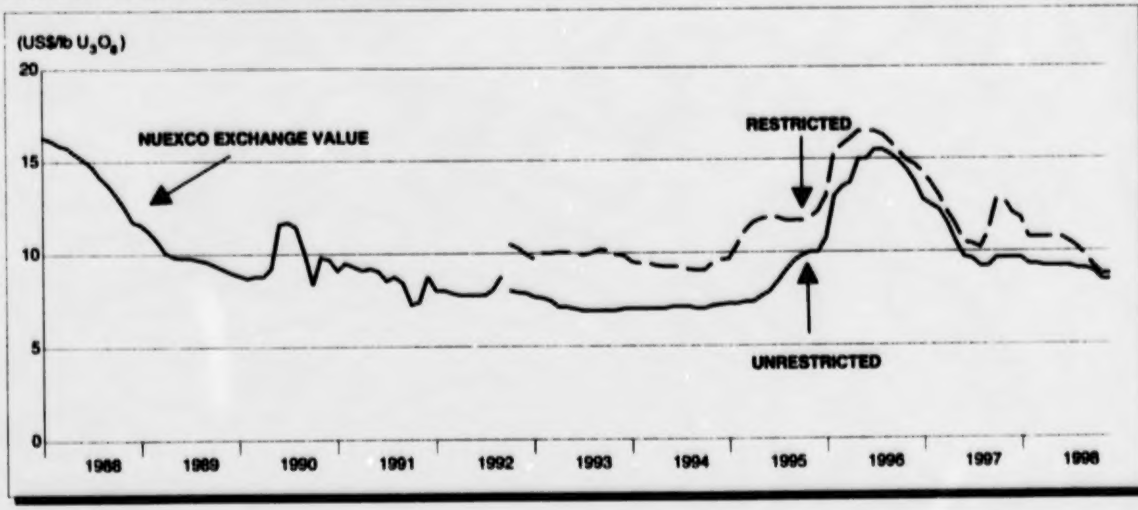
This weakened market outlook contributed to decisions announced by a number of uranium companies around the world during the second half of the year to defer the development of new mines, shut down existing mines, or scale back production to coincide with firm sales commitments. As mentioned above, both CRI and Cameco announced adjustments to their Saskatchewan operations during this period.

On September 22, 1998, U.S. Secretary of Energy Richardson and Minister Adamov of Minatom issued a joint report on the status of implementation of the highly enriched uranium agreement. This report contained a number of commitments on both sides designed to encourage the resumption of commercial negotiations. Significant among these was a commitment by the United States to defer further uranium sales by the Department of Energy. On October 21, 1998, the U.S. Congress passed legislation appropriating up to US$325 million for the purchase of the quantities of uranium associated with the 1997 and 1998 deliveries by Russia of blended down nuclear weapons material. Expenditure of the funds was conditional upon the Russians signing a commercial agreement for the sale of the uranium feed from 1999 forward. Commercial negotiations resumed in December with senior U.S. and Russian officials participating in the talks.

Uranium Prices

The increase in spot market prices during the second half of 1997 proved to be unsustainable, giving way to an almost continuous decline throughout 1998. The "restricted" market price fell from US$12.05/lb U_3O_8 at the beginning of the year to close at US$8.75/lb U_3O_8. The "unrestricted" price, attributable to uranium from the former Soviet Union, declined over the course of the year from US$9.65/lb U_3O_8 to US$8.45/lb U_3O_8. These prices, reported by TradeTech,[4] were influenced mainly by a lack of demand in the spot market and strengthened only briefly during the second quarter. In fact, the total volume transacted on the spot market was less than 3900 tU, the lowest yearly spot volume in over a decade. The marketing plans enclosed in USEC's registration statement altered perceptions of the longer term supply and demand balance, and contributed to the decline in spot prices throughout the second half of the year.

Figure 5
Trend in Uranium Spot Prices, 1988-98



Source: TradeTech.

It took the announcement of several significant mine closures and production cutbacks, including those by Cameco and CRI, to counteract these perceptions. Since the end of the year, spot prices have begun to recover. Figure 5 shows the development of uranium spot prices from 1988, which is the last time prices were above US$15.00/lb U_3O_8.

The average price of Canadian export deliveries also decreased from $51.30/kgU (US$14.20/lb U_3O_8) in 1997 to US$51.10/kgU (US$13.30/lb U_3O_8) in 1998, reflecting mainly the decline in spot prices. Canadian producers were, to a large degree, sheltered from the price decline during 1998 by the weakness of the Canadian dollar against the U.S. currency. Table 8 shows the export price trend from 1975 to 1998, while Table 9 indicates actual exports of Canadian-origin uranium to principal customers from 1992 to 1997. The destination of Canada's exports of uranium in concentrates on a cumulative basis (1993-97 inclusive) is illustrated in Figure 6, which highlights the importance of the United States as a major customer.

REFINING AND CONVERSION

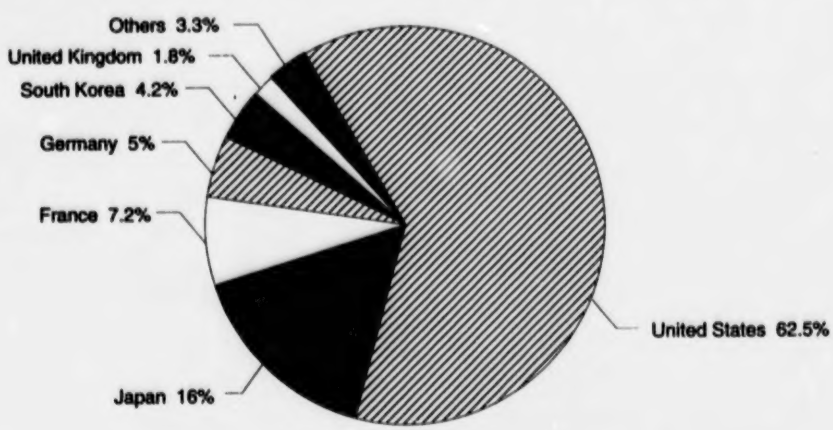
Cameco operates Canada's only uranium refining and conversion facilities, located at Blind River and Port Hope, Ontario, respectively. At the Blind River refinery, which is the world's largest, uranium mine concentrates from Canada and abroad are refined to uranium trioxide (UO_3), an intermediate product. The UO_3 is then trucked to the Port Hope facilities, which have about one quarter of the Western World's annual uranium hexafluoride (UF_6) conversion capacity and currently provide the only commercial supply of fuel-grade natural uranium dioxide (UO_2). UF_6 is enriched outside Canada for use in foreign light-water reactors, while natural UO_2 is used to fabricate fuel bundles for CANDU reactors in Canada and abroad. About 80% of the UO_3 from Blind River is converted to UF_6, while the remaining 20% is converted to UO_2. Table 10 tabulates Canada's production of refined and converted uranium, and notes the associated work force from 1994 to 1997, inclusive.

Cameco's reduced uranium production will have an impact on these fuel services facilities. In 1999, summer shut-downs will be extended to ten weeks from four at Blind River, and to thirteen weeks from four at Port Hope. About 315 employees will be laid off during these shut-downs. In addition, five positions at each of the two plants will be eliminated.

NUCLEAR POWER DEVELOPMENTS

In 1998, nuclear plants generated about 13% of Canada's electricity, mainly in the province of Ontario. During the year, Ontario Hydro continued its Nuclear Recovery Program, based on recommendations from the *Independent, Integrated Performance Assessment* (IIPA). Four units at Pickering A and the three operational units at Bruce A were laid up in early 1998 (Bruce A Unit 2 was mothballed in

Figure 6
Canadian Uranium Exports, by Country of Final Destination, 1993-97



Exports over five years total 48 818 tU.

Source: Atomic Energy Control Board (AECB), Canada.

1995). The reactor lay-up is not because of safety problems, but was deemed necessary to focus on improving the performance of the newer units still in operation. Progress toward Ontario Hydro's goal of returning to world-class performance was evident in the improved performance of the 12 operating units at the Pickering, Bruce and Darlington stations in 1998. Decisions regarding the re-start of the Pickering A units are expected in the spring of 1999. Decisions relating to Bruce A re-starts will depend on the overall success of the 12-unit recovery plan, system needs, and the results of a business case analysis. The relevant statistics for Canada's nuclear energy program are provided in Tables 11 and 12.

AECL submitted a bid for a CANDU nuclear station at Akkuyu, Turkey, in response to the Turkish invitation to bid that was issued in December 1996. AECL is one of three vendors contending for the project. The winning bid has not yet been announced, but a decision is expected in the spring of 1999 (after national elections). At Wolsong in South Korea, construction of two of the three remaining CANDU reactors to be built proceeded on schedule. Unit 3 was brought into service in June 1998, and Unit 4 construction was nearly complete at year's end. Wolsong Unit 2, brought into service in 1997, continued to perform well throughout 1998. AECL also began construction of the first of two reactors for the China National Nuclear Corporation in June 1998.

Outlook

By early 1999 it appeared that many of the remaining obstacles had been addressed, and the prospects appeared to be good for the eventual conclusion of the commercial transaction that would allow natural uranium derived from the dismantling of Russian nuclear weapons to move smoothly into Western commercial markets. If the agreement is finally concluded during 1999, the uncertainty overhanging the international uranium market will be significantly reduced, providing a more stable environment for long-term investment decisions. That, in turn, should enable Canada to remain a stable and competitive supplier of uranium to world markets for the foreseeable future.

Improved market conditions will be welcomed by Canadian producers as they enter an important period of transition in 1999. As mineable reserves at Key Lake, Rabbit Lake and Cluff Lake near depletion, new high-grade mines are poised to enter into production, beginning with McClean Lake and McArthur River, followed by Cigar Lake. Successfully bringing these operations on stream will ensure that Canada remains the world's premier uranium producer well into the next century.

Endnotes

[1] John French, Advisor, Uranium Markets (tel. (613) 995-7474), has contributed to the text in those sections dealing with international uranium market developments and uranium prices.

[2] *Canada's Uranium Industry - World's Largest High-Grade Uranium Mines Proceeding*, NRCan Mailing, August 14, 1998.

[3] In certain cases, the identified operator has reported the total expenditures of a joint-venture effort. Therefore, contributions by other parties not responding to the NRCan survey are accounted for in the $39 million total expenditure for 1996.

[4] NUEXCO, an international uranium brokerage firm, was originally called the Nuclear Exchange Corporation. Several companies in the NUEXCO organization that were associated with uranium trading declared bankruptcy in early 1995. Certain of these have been reorganized and continue to provide brokerage services. NUEXCO's publication activities are carried on by TradeTech.

Note: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of March 1, 1999. (3) This paper, and other information on developments in Canadian nuclear policy, can be accessed on the Internet at http://nuclear.nrcan.gc.ca/.

TABLE 1. URANIUM PRODUCTION AND ASSOCIATED WORK FORCE IN CANADA, 1995-97

Province and Producer	Company Work Force[1] (Dec. 31)			Annual Output[2] (tU)		
	1995	1996	1997	1995	1996	1997
ATHABASCA BASIN, SASKATCHEWAN						
Cluff Mining (COGEMA Resources Inc., 100%)	208	234	222	1 214	1 926	1 964
Key Lake JV (Cameco)	397	395	316	5 464	5 429	5 434
Rabbit Lake JV (Cameco)	249	281	285	3 148	3 973	4 633
McClean Lake (pre-production)	..	214	225	–	–	–
McArthur River (pre-production)	..	..	57	–	–	–
Subtotal	854	1 124	1 105	9 826	11 328	12 031
ELLIOT LAKE, ONTARIO						
Rio Algom Limited						
Stanleigh	488	31	–	647	378	–
Total	1 342	1 155	1 105	10 473	11 706	12 031

Sources: Company annual reports; Atomic Energy Control Board open files.
– Nil; .. Not available.
[1] Figures are for company-payroll employees only; on-site contractors (mining, construction, services, etc.) are not included. [2] Primary output only. With the closure of Rio Algom's Stanleigh operation at Elliot Lake in mid-1996, by-products from Cameco's refinery/conversion facilities are no longer processed in Canada. Prior to 1997, by-product totals were NOT included in the Canadian totals of primary uranium production noted above, but were included in the shipments and value of shipments figures provided in Table 2.

TABLE 2. VALUE[1] OF URANIUM SHIPMENTS[2] BY PRODUCERS IN CANADA, 1994-98

	Unit	1994	1995	1996	1997	1998
Total producer shipments	tU	11 253	10 293	11 396	11 127	9 984
Total value of shipments[3]	C$ millions	625	534	624	554	500

Source: Natural Resources Canada.
[1] Value of shipments includes the value of uranium recovered from the refinery/conversion facility by-products noted in Table 1, which are not included in primary production. [2] Shipments in tonnes of uranium (tU), contained in concentrate, from ore-processing plants. [3] Estimates derived using an average market price.

TABLE 3. OPERATIONAL CHARACTERISTICS OF EXISTING CANADIAN URANIUM PRODUCTION CENTRES, 1997

Operating Entity (Operator)/Location	Ore-Processing Plant[1]			
	Capacity	Recovery	Annual Throughput	
	Nameplate	Overall	Total Ore	Ore Grade
	(t/d)	(%)	(t)	(%)
Cluff Mining (COGEMA Resources Inc.)/ Cluff Lake, Saskatchewan	800	98	332 800	0.60
Rabbit Lake JV (Cameco Corporation)/ Rabbit Lake, Saskatchewan	2 000	95	373 860	1.52
Key Lake JV (Cameco Corporation)/ Key Lake, Saskatchewan	710	97	315 280	2.09

Sources: Corporate annual reports; Atomic Energy Control Board open files.
[1] Figures are rounded.

TABLE 4. SUMMARY, CANADIAN URANIUM MINING PROJECTS, AS OF MARCH 1, 1999

Project, Province/Operator	Owners Share (%)	Deposit Type/ Discoverer and Discovery Date	Resources (Company Estimates as of March 1, 1999)	Ore Grade and Notes on Deposits	Mining Method, Milling Rate and Capacity	Project Particulars and Status	Location of Project/ Notes of Interest
NEW PROJECTS PLANNED FOR PRODUCTION							
Cigar Lake, Sask./ Cigar Lake Mining Corporation	Cameco (48.75), COGEMA (36.375), Idemitsu (7.875), TEPCO (5), KEPCO (2 non-voting)	Unconformity-related/ COGEMA 1981	Overall property 136 000 tU, *mineable*	Overall property grade of 12% U; grades vary from 5% to 70% U; orebody at depth of 450 m	"Non-entry" underground; "jet-boring" mining method; milling at McClean Lake and Rabbit Lake; contributing from 2300 to 6900 tU/y	C$555 million project; test mining completed in 1992; EIS submitted in October 1995; Joint Panel reports November 1997; government approval April 1998	670 km N of Saskatoon; 500-m-deep shaft sunk; brine freezing of ground is required to mine the ore; production to begin 2001/2
McClean Lake, Sask./COGEMA Resources Inc.	COGEMA (70), Denison (22.5), OURD (7.5)	Unconformity-related/ original McClean by CanOxy/Inco 1979-80; JEB & Sue *et al* - 1982 to 1990 by Minatco Ltd.	Overall property 17 300 tU, *mineable*	2.7% U average overall; open-pit depths from 20 to 145 m; McClean underground ore to 4% U at depth of 170 m	75% by open pit at JEB, Sue A, B & C; underground at McClean; mill capacity may be expanded to mill Cigar Lake ore	C$200 million project (alone); public hearings in 1993; approved subject to AECB licensing process; construction completed during 1997	350 km N of La Ronge; JEB open-pit mining started in 1996; milling delayed until 1999; mine life of the co-enterprise >2010
Midwest Project, Sask./COGEMA Resources Inc.	COGEMA (56), Denison (19.5), Cameco (20), OURD (4.5)	Unconformity-related/ Esso Minerals 1977 (interests of Bow Valley, Numac Oil & Gas, *et al* bought by partners)	Overall property 13 000 tU, *mineable*	Overall property grade of 4% U; grades vary from 2% to 30% U; orebody at depth of 200 m	"Non-entry" underground; "jet-boring" mining method; milling at McClean Lake; contributing 2300 tU/y	$80 million co-venture with McClean; in 1993, Joint Panel rejects proposal; new EIS in 1995; final hearings August 1997; Joint Panel report November 1997; government approval April 1998	710 km N of Saskatoon; 185-m-deep test-mine shaft; new operator, COGEMA, revised EIS; start-up in 2003 (?)
McArthur River, Sask./Cameco Corporation	Cameco (83.766), COGEMA (16.234)	Unconformity-related/ Cameco 1988	Overall property 186 000 tU; but 98 000 tU *mineable*	Overall property grade varies from 2% to 70% U, but averages 13% U; *mineable* grade 16% U; orebody at depth of 550 m	"Non-entry" underground mining method with milling at Key Lake; licensed mill capacity 6150 tU/y but expandable to 6900 tU/y	C$400 million project; 1993 underground exploration; EIS December 1995; public hearings 1996; Joint Panel report February 1997; government approval May 1997	80 km NE of Key Lake; construction licence August 1997; start-up expected late 1999; will extend operations at Key Lake mill beyond 2015
Kiggavik, N.W.T./ Urangesellschaft Canada Limited	Urangesellschaft (79), COGEMA (20), Daewoo Corp. (1)	Unconformity-related/ Urangesellschaft 1977	Overall property 15 000 tU, *mineable*; (more incl. Andrew Lake *et al*)	0.41% U average overall; depth Centre pit 100 m, Main pit 200 m	Open-pit mining methods; 1200 t/d mill feed; output rate of 1200 tU/y originally expected	EIS submitted but project deemed deficient by Panel; COGEMA expected to review project and submit new EIS	75 km W of Baker Lake; start-up not likely before 2005; >11-year mine life with tributary ore included
RECENTLY APPROVED EXTENSIONS OR EXPANSIONS TO EXISTING OPERATIONS							
Dominique-Janine Extension (DJX) at Cluff Lake, Sask./ COGEMA Resources Inc.	COGEMA Resources Inc. (100)	Unconformity-related/ "D" pit by Mokta 1969 (depleted 1981); Claude *et al*/Amok 1970-76 (Claude depleted 1989); D-J & Dominique-Peter 1980-86	Overall property 13 000 tU *mineable*, Dominique-Janine Extension 5000 tU, *mineable*	Mill-feed grade for 1996 was 0.63% U; DJX to mine >680 000 t of ore grading 0.73% U to yield in excess of 5000 tU	Open pit at DJX before underground; re-licensed mill capacity to 2020 tU/y; milling rate being increased from half-capacity operation	C$10 million Cluff Lake extension; hearings in 1993; approval to proceed subject to AECB licensing; mining well under way in 1995	720 km N of Saskatoon; revised three-phase mine plan offers mining flexibility; operations to be suspended mid-2000
Eagle Point & Collins Bay at Rabbit Lake, Sask./Cameco Corporation	Cameco (100)	Unconformity-related/Gulf Minerals 1968; Rabbit Lake (depleted 1984); 1971-79 for Collins Bay ("B" pit depleted 1991); 1980 for Eagle Point	Eagle Point *et al*, 18 000 tU *mineable*, overall property 27 000 tU (incl. stockpiles)	Mill-feed grade for 1996 was 1.58% U; mineable grade 1.2% U for Eagle Point and 3.45% U for Collins "A&D"; Eagle Pit depth 120-335 m	"Non-entry" underground methods at Eagle Point, open pit for others; milling rate below 5400 tU/y licensed capacity, but increased in 1995	Eagle Point test mining 1992; Joint Panel reviewed and federal government approved in 1993; Eagle Point in production, Collins A & B mined	805 km N of Saskatoon; mining Eagle Point ore since late June 1994; Eagle Point mining to be suspended March 31, 1999

Notes: OURD (Canada) Co., Ltd. is a subsidiary of the Overseas Uranium Resources Development Corporation (OURD) of Japan. Urangesellschaft Canada Limited, operated by Cogema Resources Inc., is a subsidiary of Compagnie générale des matières nucléaires (COGEMA) of France. Idemitsu Uranium Exploration Canada Ltd. is a wholly owned subsidiary of Idemitsu Kosan Co., Ltd. of Japan. Korea Electric Power Corporation (KEPCO) is South Korea's only nuclear-electric utility. In June 1997, COGEMA acquired the 20% interest in the Kiggavik (Northwest Territories) project that Cameco had purchased earlier in the year when it acquired Power Resources Inc. The Tokyo Electric Power Co., Inc. (TEPCO), Japan's largest nuclear power utility, acquired a 5% interest in Cigar Lake from Idemitsu Kosan in mid-1997.

TABLE 5. URANIUM EXPLORATION ACTIVITY IN CANADA, 1982-97

Year	Expenditures[1]	Drilling[2]	Million-Dollar Projects[3]
	(C$ millions)	(km)	(number)
1982	71	247	13
1984	35	197	12
1986	33	162	11
1987	37	164	12
1988	59	201	11
1989	58	158	11
1990	45	66	6
1991	44	67	4
1992	46	79	4
1993	40	62	5
1994	36	67	8
1995	44	75	10
1996	39	79	8
1997	58	104	6

Source: Natural Resources Canada.
[1] Direct exploration and drilling expenditures in current dollars; from the late 1980s, includes advanced underground exploration and deposit appraisal expenditures; from the mid-1990s, may also include care-and-maintenance costs associated with deposits awaiting production approvals.
[2] Exploration and surface development drilling; excludes development drilling on producing properties. [3] Number of projects where direct exploration and drilling expenditures exceeded C$1 million in current dollars.

TABLE 6. ESTIMATES OF CANADA'S URANIUM RESOURCES RECOVERABLE FROM MINEABLE ORE,[1] JANUARY 1, 1997, AND JANUARY 1, 1998

Price Ranges Within Which Mineable Ore is Assessed[2]	Measured		Indicated		Inferred	
	1/1/97	1/1/98	1/1/97	1/1/98	1/1/97	1/1/98
			(000 tU)			
Up to C$100/kgU	151	140	180	172	99	107
C$100 to $150/kgU	–	–	–	–	–	–
Total	151	140	180	172	99	107

Source: Natural Resources Canada.
– Nil.
[1] Actual or expected losses in mining recovery and ore processing have been accounted for; these factors were individually applied to resources tributary to existing or prospective production centres. In underground operations, mineable ore is generally 75% to 85% of the ore-in-place; higher mining recoveries are achievable in open-pit operations. Canada's weighted average ore processing recovery for existing conventional operations exceeded 97% over the 1996/97 period.
[2] The Canadian dollar figures reflect the price of a quantity of uranium concentrate containing 1 kg of elemental uranium. The prices were used in determining the cut-off grade at each deposit assessed, taking into account the mining method used and the processing losses expected. The price of C$100/kgU was used by Natural Resources Canada to illustrate those resources that were of economic interest to Canada during the survey period.
Note: $1/lb U_3O_8 = $2.6/kgU.

TABLE 7. PRODUCTION OF URANIUM IN CONCENTRATES BY SELECTED MAJOR PRODUCING COUNTRIES, 1993-97

	1993	1994	1995	1996	1997
			(tonnes U)		
Canada[1]	9 190	9 700	10 530	11 750	12 030
Russia	2 700	2 350	2 200	2 600	2 000
Kazakstan	2 700	2 240	1 580	1 210	1 000
Uzbekistan	2 700	2 120	1 700	1 460	1 760
China	950	480	780	560	500
United States	1 290	1 290	2 324	2 430	2 170
South Africa	1 710	1 670	1 420	1 440	1 100
Namibia	1 670	1 900	2 010	2 450	2 900
Australia	2 270	2 210	3 710	4 970	5 520
Niger	2 910	2 980	2 980	3 320	3 500
France	1 710	1 050	1 020	930	750
Gabon	550	650	630	570	470
Other[2]	2 770	2 370	2 730	2 540	1 990
Total[3]	33 120	31 010	33 610	36 230	35 690

Sources: *Uranium: Resources, Production and Demand*, a biennial report published jointly by the Nuclear Energy Agency of the OECD and the International Atomic Energy Agency; miscellaneous corporate, national and international reports.
[1] Figures include refinery/conversion facility by-product uranium, and differ from primary production figures shown elsewhere. [2] Includes Argentina, Belgium, Brazil, Bulgaria, China, the Czech Republic, Germany, Hungary, India, Israel, Japan, Mongolia, Pakistan, Portugal, Romania, Spain, Ukraine and Yugoslavia. [3] Totals are of the listed figures only and represent global production.
Note: Country figures are rounded to the nearest 10 tU.

TABLE 8. CANADIAN URANIUM EXPORT PRICE,[1] 1975-98

Year	Average Export Prices: Current Dollars	Average Export Prices: Constant 1998 Dollars	Spot Sale Portion of Deliveries
	(C$/kgU)[2]		(%)
1975	52	143	n.r.
1976	104	261	n.r.
1977	110	259	n.r.
1978	125	276	n.r.
1979	130	262	n.r.
1980	135	245	n.r.
1981	110	180	1
1982	113	170	1.5
1983	98	140	10
1984	90	125	26
1985	91	123	20
1986	89	117	21
1987	79	99	35
1988	79	95	13
1989	74	85	<1
1990	71	79	<1
1991	61	66	<2
1992	59	63	<1
1993	50	53	<1
1994	51	53	<1
1995	47	48	2
1996	53.60	53.78	1
1997	51.30	51.09	<1
1998	51.10	51.10	<2

Source: Natural Resources Canada.
n.r. Not reported.
[1] NRCan derives the Export Price figure annually based on the average price under all export contracts made by Canadian producers for deliveries in the given year. [2] $/kgU x 0.38465 = $/lb U_3O_8.
Notes: Prices are rounded. Constant dollar values are derived using the Implicit Price Index for Gross Domestic Product.

TABLE 9. EXPORTS OF URANIUM OF CANADIAN ORIGIN, 1992-97

Country of Final Destination	1992	1993	1994	1995	1996	1997
	(tonnes of contained uranium[1])					
Argentina	20	29	–	–	–	–
Belgium	–	–	115	3	115	–
France	111	461	766	1 016	679	587
Germany	534	665	465	348	776	184
Japan	2 328	523	3 443	363	1 490	1 968
South Korea	104	715	455	290	261	315
Spain	–	–	274	186	103	160
Sweden	170	–	–	84	142	450
United Kingdom	19	–	50	188	250	374
United States	4 032	6 291	4 938	5 702	7 407	6 187
Total	7 318	8 684	10 506	8 180	11 223	10 225

Source: Atomic Energy Control Board.
– Nil.
[1] Some of this uranium was first exported to an intermediate country for conversion and/or enrichment prior to transfer to the country of final destination.

TABLE 10. URANIUM PROCESSING PRODUCTION AND ASSOCIATED WORK FORCE IN CANADA, 1994-97

Process and Location (Nameplate Capacity)	Production				Site Work Force			
	1994	1995	1996	1997	1994	1995	1996	1997
	(tU)				(number)			
Refining at Blind River ($18\ 000$ tU as UO_3)	9 445	10 729	10 190	12 195	81	86	90	102
Conversion at Port Hope (10 500 tU as UF_6 and 2500 tU as UO_2)	9 490	10 552	10 127	12 594	198	231	257	277

Source: Cameco Corporation.

TABLE 11. NUCLEAR POWER PLANTS IN CANADA – INSTALLED CAPACITY AS OF DECEMBER 31, 1998

Reactors	Owner	Net Capacity	In-Service Dates
		(MWe)	
Pickering 1 to 4	Ontario Hydro	2 060	1971-73
Bruce 1 to 4[a]	Ontario Hydro	3 076	1977-79
Point Lepreau	NB Power[1]	635	1983
Gentilly 2	Hydro-Québec	638	1983
Pickering 5 to 8[b]	Ontario Hydro	2 064	1983-86
Bruce 5 to 8	Ontario Hydro	3 440	1984-87
Darlington 1 to 4	Ontario Hydro	3 524	1990-93
Total net capacity		15 437	

Source: Natural Resources Canada.
[a] Bruce Unit 1 out of service on Octobe 16, 1997; Bruce Unit 2 out of service on October 3, 1995, and being mothballed; Bruce Unit 3 out of service on April 9, 1998; Bruce Unit 4 out of service on March 17, 1998. [b] Pickering Units 1-4 taken out of service indefinitely at the end of 1997.
[1] New Brunswick Power Corporation.

TABLE 12. NUCLEAR POWER DATA IN CANADA AS OF DECEMBER 31, 1998

	Unit	Canada	Ontario	New Brunswick	Quebec
Electricity demand growth	%	0.4	1.1	0.7	-3.8
Nuclear share of electric utility generation	%	13.4	43.8	21.1	2.8
Reactors in service	no.	14	12	1	1
Capacity in service	Net MWe	10 301	9 028	635	638

Source: Natural Resources Canada.

Zinc

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World zinc consumption reached 7.8 Mt in 1998, according to preliminary figures from the International Lead and Zinc Study Group (ILZSG), a total that was slightly less than world refined metal production of 7.9 Mt. Western World zinc demand exceeded production by 731 000 t. This supply deficit was largely offset by net exports of zinc metal to the West by Eastern countries. Zinc metal stocks held on the London Metal Exchange (LME) fell steadily throughout the year to 317 000 t, a decline of 175 000 t since the end of 1997.

Despite what should have otherwise been improved market conditions over 1997, the overlying uncertainties related to the turmoil in Southeast Asian currency markets and the overall economic downturn in Asian, and particularly Japanese, markets overshadowed the market fundamentals for zinc, resulting in weaker prices throughout the year. Zinc cash settlement prices on the LME averaged US$1023/t in 1998, a 22% decrease over 1997.

Canadian Developments

Zinc mine production in Canada totalled 1 062 812 t in 1998, about 1% lower than in 1997. The closure of Anvil Range's Faro operations and Breakwater Resources' Caribou and Restigouche mines in mid-year was offset somewhat by increased production at existing mines and the start-up of the zinc circuit at Agnico-Eagle's existing gold mine in late September. For 1999, a 2% increase in zinc mine production is forecast as mines that opened late in 1998 complete a full year of production.

Zinc metal production in Canada was up 5% from 703 798 t in 1997 to 743 170 t in 1998, primarily as a result of the completion of the 20 000-t/y expansion projects at Cominco's Trail operations in British Columbia and at Noranda's Valleyfield zinc refinery in Quebec.

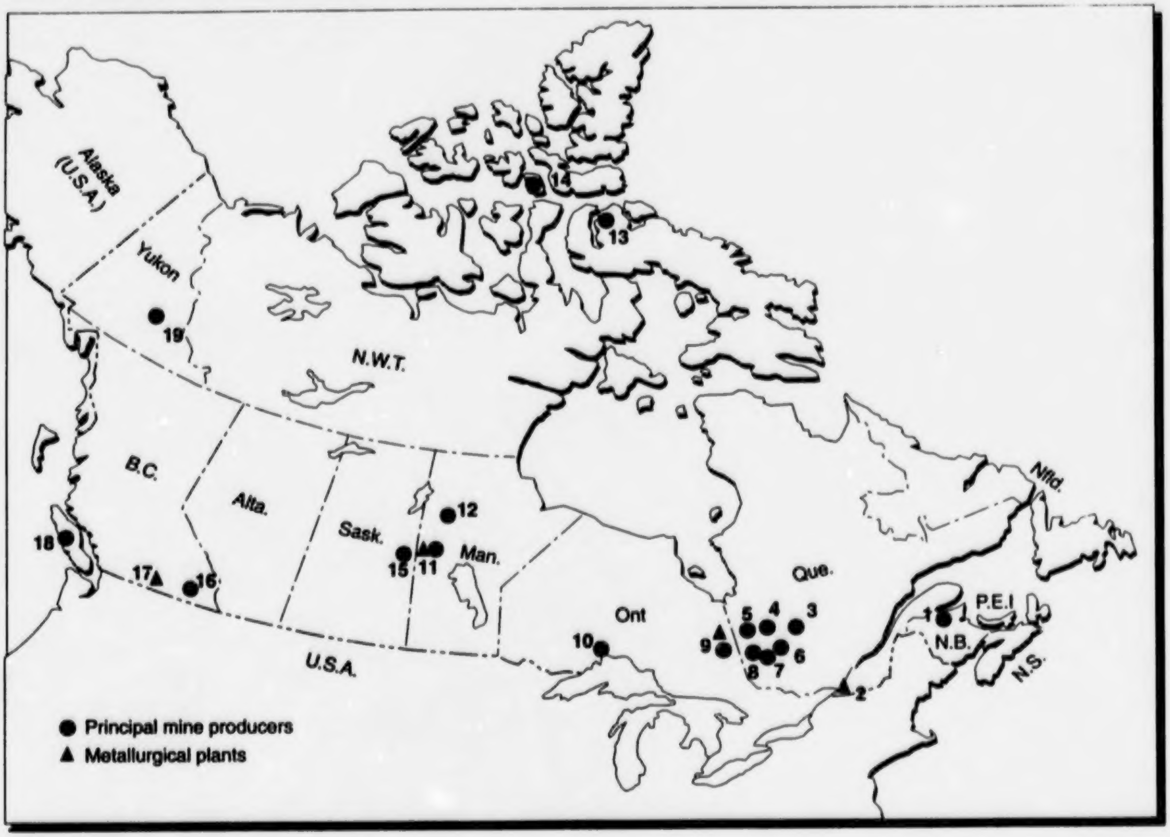
British Columbia

In February 1998, Boliden Limited successfully acquired the assets of Vancouver-based Westmin Resources Limited for approximately US$360 million, including the Myra Falls underground polymetallic zinc-copper mine on Vancouver Island, British Columbia. In November, Boliden announced that it was temporarily suspending production at Myra Falls in mid-December to implement a plan designed to address challenging ground conditions in the Battle Zone of the mine. Full production is scheduled to resume by April 1, 1999. Milling will continue at 50% capacity throughout the suspension period to process waste rock for use as backfill.

In March, following a three-year environmental assessment, Redfern Resources received approval from the B.C. and federal governments to re-open the Tulsequah Chief mine in northwestern British Columbia subject to the fulfilment of certain conditions by Redfern. The mine has been shut down since 1957. Prior to closure, the ore was shipped out to sea by barge, passing through the Alaska panhandle. Despite the involvement of the state of Alaska and the U.S. government in the environmental assessment process, the United States has asked Canada to agree to the International Joint Commission (IJC) holding a review of the project because of Alaska's continuing concerns that liquid effluent from the mine could harm salmon and trout in the nearby Taku River, which flows across the border into Alaska.

An expansion project at Cominco's zinc plant at Trail, British Columbia, increased capacity by 20 000 t/y of refined zinc in 1998 for a total capacity of 290 000 t/y. In June, Cominco's Trail operations won the "Ethics in Action" award for ethical decision-making. The award is sponsored by a group of businesses and groups in the Vancouver area to recognize and encourage organizations who go beyond basic economic and legal responsibilities, and who act in a manner that fairly balances competing needs and values in the interests of their communities and stakeholders.

Figure 1
Zinc Producers in Canada, 1998



Numbers refer to locations on map above.

ZINC-PRODUCING MINES

1.	Brunswick #12	Noranda Mining and Exploration Inc.
	Heath Steele	Noranda Inc.
	Caribou/Restigouche	Breakwater Resources Ltd. (suspended Aug. 98)
3.	Gonzague-Langlois	Cambior Inc.
4.	Isle Dieu	Bell Allard
5.	Selbaie	Les Mines Selbaie
6.	Louvicourt	Aur Resources Inc./Novicourt Inc.
7.	LaRonde	Agnico Eagle Mines
8.	Bouchard-Hébert	Audrey Resources Inc.
9.	Kidd Creek	Falconbridge Limited
10.	Winston Lake	Inmet Mining Corporation (closed Oct. 98)
11.	Flin Flon	Hudson Bay Mining and Smelting Co., Limited
	Callinan	Hudson Bay Mining and Smelting Co., Limited
	Trout Lake	Hudson Bay Mining and Smelting Co., Limited
12.	Ruttan	Hudson Bay Mining and Smelting Co., Limited
13.	Nanisivik	Breakwater Resources Ltd.
14.	Polaris	Cominco Ltd.
15.	Konuto Lake	Hudson Bay Mining and Smelting Co., Limited
16.	Sullivan	Cominco Ltd.
18.	Myra Falls	Boliden Limited
19.	Faro (Grum)	Anvil Range Mining Corporation (closed Feb. 98)

ZINC METALLURGICAL PLANTS

2.	Valleyfield	Canadian Electrolytic Zinc Limited
9.	Kidd Creek	Falconbridge Limited
11.	Flin Flon	Hudson Bay Mining and Smelting Co., Limited
17.	Trail	Cominco Ltd.

Yukon

Anvil Range announced in February 1998 that weak base-metal markets had forced it to shut down its wholly owned Faro lead-zinc operations in the Yukon. The Faro operations comprise a crushing, milling and concentrating facility and three base-metal deposits. Commercial production had been reactivated in November 1995, but the company suspended mining in December 1996, citing unexpectedly low metal prices, stripping delays and a strong Canadian dollar. Anvil Range re-opened the Faro operations again in November 1997. Faro has a capacity of 150 000 t/y of zinc and 98 000 t/y of lead in concentrate. The company went into receivership in April.

In December, the Supreme Court of British Columbia dismissed a legal challenge by Atna Resources against the proposed sale of Boliden's 60% interest in the Wolverine project to Expatriate Resources. Atna, which owns the remaining 40% interest in the project, claimed that its right of first refusal, contained in the joint-venture agreement with Boliden Westmin, had been triggered by the intended sale. The deal involves the sale of Boliden's mineral interests in the Finlayson Lake district of southeastern Yukon, including its 60% interest in the Wolverine joint venture and the wholly owned Tuchita property. The Wolverine deposit contains an estimated 6.2 Mt grading 12.66% zinc, 1.33% copper, 1.55% lead, 370.9 g/t silver and 1.76 g/t gold.

Saskatchewan/Manitoba

In September, Hudson Bay Mining and Smelting Company (HBM&S) opened the $17.1 million Chisel North zinc mine project that effectively replaced the Photo Lake mine, which was closed due to ore exhaustion. The Chisel North mine is being developed in two phases with approval of the second phase dependent upon performance in Phase 1 and on final confirmation of the size of the orebody. The total cost of both phases is estimated at about $50 million.

In November, HBM&S released information on its newest ore deposit near Flin Flon, Manitoba, called the Triple Seven deposit. The deposit is a volcanic hosted, massive sulphide located within the Flin Flon/Callinan mine horizon that contains three rich ore lenses totalling 13.36 Mt. Combined, the lenses grade 2.71 g/t gold, 37.71 g/t silver, 3.32% copper and 5.78% zinc.

Development of the Konuto Lake copper-zinc mine west of Flin Flon in northern Saskatchewan also continued in 1998, and it is expected to start commercial production in the first quarter of 1999. Konuto Lake will produce 3500 t/y of zinc.

Ontario

Inmet Mining announced in the third quarter of 1998 that it was suspending all operations at its Winston Lake mine as a result of low zinc prices. The company also announced that it had lowered its estimates for ore reserves in the lower Pick Lake zone. A decision on whether to permanently close the mine or put it on care and maintenance until zinc prices improve is expected in early 1999.

Quebec

Work continued during the year at Agnico Eagle's zinc circuit, which came on stream at the end of September. The zinc-rich zone is being developed in the existing LaRonde gold mine near the town of Cadillac in the Abitibi region of northwestern Quebec. Expenditures on the expansion program at LaRonde, including mill construction and shaft sinking, totalled $11 million in the second quarter of 1998, leaving approximately $193 million to spend over the next three and a half years. By the year 2000, LaRonde will produce 52 000 t/y of zinc in concentrate.

Noranda completed a $32 million optimization of the hydro-metallurgical process at its Valleyfield zinc refinery. The project increased the plant's zinc refining capacity by 20 000 t/y. Development of Noranda's Bell Allard zinc-copper mine in the Matagami region of Quebec is on target for production start-up in the third quarter of 1999. The zinc-copper mine is expected to have a life of approximately five years with a milling capacity of 2000 t/d. The Bell Allard mine will benefit from Noranda's existing infrastructure in the Matagami region.

New Brunswick

Breakwater Resources announced in August that it would extend indefinitely the five-week shut-down at its Caribou zinc-lead mine in New Brunswick. The company cited metallurgical results that have been steadily improving but which had not reached the desired levels and weak metal prices as factors that led to the shut-down. The company recommissioned the Caribou underground mine in conjunction with the opening of the nearby open-pit Restigouche zinc-lead mine in the third quarter of 1997. At full production, the Caribou mill, which treated ore from both mines, had a production capacity of 67 000 t/y of zinc and 32 000 t/y of lead in concentrate.

WORLD DEVELOPMENTS

Total world mine production of zinc was 7.4 Mt in 1998, a slight increase of 1.1% from 1997. World zinc metal production reached 7.9 Mt, an increase of 2.2% over 1997, due largely to increased production in Kazakstan and Russia.

According to ILZSG figures, Western World zinc mine production increased 1.8% in 1998 to a total of 5.58 Mt. In Europe, increases in Sweden were offset by declines in Ireland and Spain and the cessation of zinc mining in Norway due to mine closures. African output rose as a result of increased production in Morocco and the re-opening of Breakwater Resources' Bougine mine in Tunisia. North American output increased substantially as a result of the 15% rise in U.S. production from Cominco's Red Dog mine in Alaska. Latin American production fell 4% as a result of closures in Brazil and the suspension of operations at the El Toqui mine in Chile.

Western World zinc metal production rose for the fourth consecutive year by 2.4% to 5.7 Mt in 1998. The main increases were as a result of expansions in Canada, South Korea, Thailand and the United States.

United States

Rio Algom Limited announced in January the formation of a wholly owned subsidiary, Nicolet Minerals Company, to develop and operate the Crandon project in the northern U.S. state of Wisconsin. The company derives its name from Jean Nicolet, a French-Canadian explorer who explored the regions west of Lake Michigan and Wisconsin in the early 1600s. Rio Algom acquired 100% of the Crandon project, establishing the company as the sole owner and operator in early January. With an estimated resource of 55 Mt comprising 30 Mt grading 9.4% zinc and 0.4% copper, and 25 Mt grading 0.7% zinc and 1.8% copper, the Crandon project is expected to produce 150 000 t of zinc in concentrate annually. A review of the project for state permitting continues. In December, Nicolet Minerals announced four major improvements in the mine design to help resolve public concerns about tailings and the treatment and discharge of water from the mine.

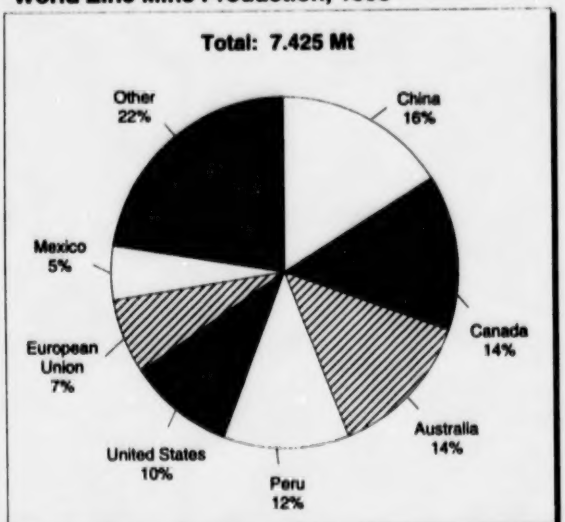
The Production Rate Increase project at Cominco's Red Dog mine was commissioned in the second quarter of 1998 and achieved its full design capacity on a sustainable basis in September. Upon completion of the project, Cominco expects that its annual production will exceed 900 000 t of zinc in concentrate and 150 000 t of lead in concentrate.

Latin America

The first phase of a two-phase expansion project was completed in October at the Sociedad Minera Refinería de Zinc de Cajamarquilla S.A. zinc refinery near Lima, Peru. The refinery, owned by Cominco of Canada (82%) and Marubeni Corporation of Japan (17%), expanded its production capacity to 120 000 t/y of refined zinc. The second phase will eventually double the plant's capacity to 240 000 t/y when completed. Engineering work on the second phase is more than 50% complete. Construction is scheduled to begin at the end of the first quarter of 1999 and the second phase is to be ready for start-up by the end of 2000.

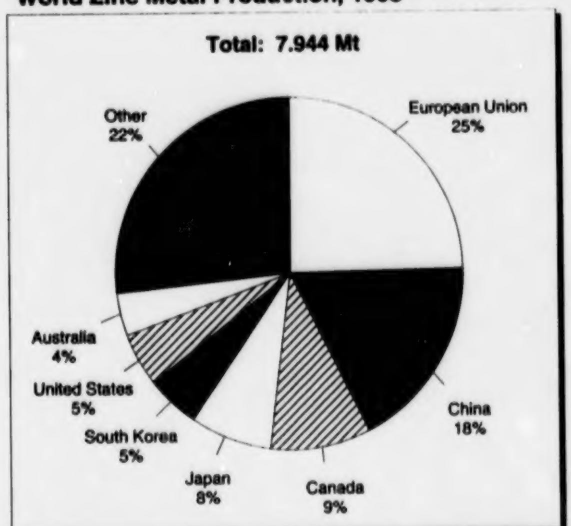
Rio Algom Limited, Noranda Inc. and Teck Corporation announced in September that they will proceed with plans to develop the US$2.2 billion Antamina

Figure 2
World Zinc Mine Production, 1998



Source: International Lead and Zinc Study Group.

Figure 3
World Zinc Metal Production, 1998



Source: International Lead and Zinc Study Group.

copper-zinc mine project in Peru. Located in the Andes Mountains approximately 380 km north of Lima, Antamina is estimated to contain 500 Mt grading 1.2% copper, 1.0% zinc, 12 g/t silver and 0.03% molybdenum, and is expected to produce an average of 270 000 t/y of copper and 160 000 t/y of zinc over a 20-year mine life. Compañia Minera Antamina S.A., the Peruvian company created to develop and operate the Antamina project, is owned 37.5% by each of Rio Algom and Noranda and 25% by Teck. Antamina is expected to begin production in 2002 and to be among the world's largest producers of copper and zinc concentrates.

Breakwater Resources Ltd. announced in November that operations at its El Mochito mine in northwestern Honduras were temporarily interrupted due to record rainfalls and as a result of Hurricane Mitch, which caused heavy damage to roads and bridges throughout the country making the shipment of concentrate to Porto Cortez and the sending of materials and supplies back to the mine impossible. Heavy rains produced significantly higher-than-normal de-watering requirements in the underground operations at the mine, resulting in large accumulations of water in the lower levels. El Mochito produces 75 000 t/y of zinc in concentrate, 12 000-13 000 t/y of lead in concentrate and 1.2 million troy oz of silver.

In August, Breakwater Resources announced the temporary suspension of milling operations at its El Toqui mine in southern Chile. The temporary suspension allowed the company to implement plans to increase production and reduce costs. The plans included the continued development of the mine, upgrading and refurbishing mining equipment, changing the mine production and mine development method, and improving the throughput and metallurgical performance of the processing facility.

Industrial Minera México, S.A. (IMMSA), a subsidiary of Grupo México S.A. de C.V., signed an agreement to license Zinc Pressure Leach Technology from Dynatec Corporation of Richmond Hill, Ontario. IMMSA operates zinc mines throughout Mexico and a zinc refinery at San Luis Potosí. Dynatec owns and licenses metallurgical technologies previously held by Sherritt International Consultants Inc. The process produces by-product elemental sulphur rather than sulphur dioxide. The technology will be provided by the Metallurgical Technologies Division of Dynatec at Fort Saskatchewan, Alberta.

Europe

In April, the Aznalcollar tailings dam at the Los Frailes mine in Spain, which is owned by Boliden Limited's indirect, wholly owned subsidiary, Boliden Apirsa SL, failed, resulting in the release of acidic water and tailings material into the local environment. Operations at the Los Frailes mine closed following the failure. In September, a technical report commissioned by the company to find the cause of the accident concluded that the accident was caused by surplus pressure in the interstitial water of the clays and by pressures due to the weight of the dam and the tailings deposited. By the end of November, Apirsa and the Spanish authorities had cleaned up most of the spill. In October and November, Apirsa applied for the licences and permits required to resume operations at Los Frailes, including the use of the depleted Aznalcollar open pit, located beside the Los Frailes mine, as a tailings disposal area. Apirsa anticipates that the required licences and permits will be issued during the first quarter of 1999.

Noranda Inc. signed joint-venture exploration agreements with Arcon International Resources Plc for properties near Arcon's zinc operations in Ireland. The two agreements cover three prospecting licences the company holds in County Offaly. Arcon continues to be the operator with exploration programs agreed to by Arcon and the Irish subsidiary of Noranda, which also signed the agreement. Noranda can earn a 51% interest in the three licences by spending a total of US$1.6 million under the two agreements. Exploration has yielded positive new results in a new zone. Arcon increased its resource/reserve base by more than 60% to more than 10 Mt since it began its exploration program in 1995, increasing the Galmoy mine's anticipated life to 15 years from 10. The average grade of the new resources was about 15.44% zinc equivalent, compared with the previous average grade of 13.53%.

Asia

In October, India's Hindustan Zinc Ltd. announced plans to expand two of its existing electrolytic zinc smelters by 20 000 t/y and to study the feasibility of building another. A feasibility study is in progress for the establishment of a 100 000-t/y electrolytic zinc smelter.

In September, Pasminco Ltd. of Australia informed authorities in Pakistan that it no longer had plans to continue development work on a lead and zinc mining project in Dhuddar, Lasbela. The company also requested approval to sell its mining rights in Balochistan Province to a third party. Pasminco spent US$10 million on the project during two years of exploration. The company cited the need to concentrate its efforts on the Century Zinc mining project in Western Australia for its decision to withdraw from Pakistan. The Dhuddar deposit contains proven and probable reserves of 6.86 Mt of ore, with another 10 Mt inferred, which is well short of Pasminco's target of 20 Mt.

South Korea's Korea Zinc Co. Ltd. expects to complete a 50 000-t/y production capacity expansion at its refinery in the southeastern city of Onsan, Korea, to 350 000 t/y in May.

In China, Baiyin Non-ferrous Metals Co. expects to start work on the Lijiagou lead-zinc project located in the western province of Gansu early in 1999. The Lijiagou mine contains proven reserves of more than 3.0 Mt that will add some 5000 t/y of lead and zinc in concentrate, raising the company's concentrate output to 32 000 t in 1999.

Africa

Anglo American Corporation announced plans to develop a US$980 million zinc mine and smelter project at the Gamsberg deposit in South Africa's Northern Cape Province. The company agreed to buy the 55% interest in the Gamsberg deposit that it did not already own and 55.4% of the Black Mountain Mineral Development Co. Ltd. lead and zinc mine from Gold Fields of South Africa Ltd. A feasibility study is to be completed by the end of 1999 to determine the smelter's location and to assess potential export markets.

Billiton Plc announced in December that it hoped to resolve by year-end a number of issues affecting a proposed 250 000-t/y zinc smelter in South Africa. The project has been delayed as the government considers possible tax and other incentives to locate the project at the proposed deep-water port of Coega, east of the Indian Ocean city of Port Elizabeth. In early December, Japan's Mitsui & Co Ltd. withdrew from the project citing the economic problems in Japan and Asia as the reason for withdrawing its participation. Billiton confirmed that it will continue with the project, together with the other remaining partner, South Africa's Industrial Development Corp. The project is expected to start production in 2003.

Australia

South Korea's Korea Zinc Co. Ltd. intends to complete its US$425 million Townsville zinc refinery by the end of 1999, despite current weak zinc prices and the slowing economy in Asia. The plant is expected to have an annual production capacity of 170 000 t of refined zinc and is owned by Korea Zinc's wholly owned unit, Sun Metals Corp. Pty Ltd.

Pasminco Ltd. resumed zinc production at its Port Pirie smelter in South Australia after a disruption caused by the failure of a spent acid tank wall in September. Following the start-up, the zinc plant operated at reduced capacity for six weeks while the previously planned installation of new equipment was completed. The two-week shut-down, together with the period of reduced capacity, resulted in a shortfall of about 2000 t of zinc.

Ausmelt Ltd. signed an agreement with Korea Zinc Co. that replaces an existing arrangement covering collaborative marketing of Ausmelt metal smelting technology for zinc residue treatment and slag fuming. The pact provides Korea Zinc with exclusive marketing rights to use Ausmelt's technology to process electrolytic zinc plant residue and fuming zinc and other metals from slag and other residues.

SECONDARY ZINC

Secondary zinc includes high-purity zinc refined from the treatment of electric arc furnace (EAF) dusts, remelted zinc with a purity less than 98.5% zinc, and scrap zinc used in the production of zinc alloys. According to ILZSG, the amount of secondary zinc recovered in the Western World has risen steadily in recent years, reaching 1.97 Mt in 1998.

The recycling of galvanized steel has become an important source of secondary zinc with processes developed to treat EAF dusts or to de-zinc steel before it is remelted. The Waelz kiln is the most common method of processing EAF dusts. Waelz oxides are treated in imperial smelting furnaces for the production of refined zinc. The requirement of Waelz kilns to be near their feed source, i.e., steel mill complexes, would suggest that treatment of these dusts will be most important in the United States, Japan and Western Europe.

Bioponic International announced in November that it was processing zinc-bearing scrap into a new metals reclamation facility in Butte, Montana, in the United States, where a chemical process converts it into a product for sale in the plant and animal nutrient market. The company claims that the process can be applied to a range of industries, including metal finishing and plating, electronics, steelmaking and mining, according to the plant operator. Bioponic International is using a process known as MR3, which incorporates 15 years of research and development, that processes the zinc-bearing scrap into a high-quality zinc sulfate monohydrate, a micronutrient product. The facility is expected to reach full production capacity by the first quarter of 1999 with an output of 350 t per month of zinc product.

Anglo-Norwegian construction and engineering group, Kvaerner ASA, announced in October that it had been awarded a US$148 million contract by CalEnergy Minerals LLC to undertake a zinc recovery project in California. The Imperial Valley project, which includes the design and construction of four ion exchange plants, is expected to produce around 27 000 t/y of zinc.

Consumption and Uses

World zinc consumption grew by less than 1% in 1998 to reach 7.8 Mt. Preliminary figures for 1998 indicate that Western World demand changed little from 1997, reaching 6.43 Mt. Increases in Europe (up 2.8%) and the United States (up 3.2%) were offset by weaker demand in Asia, and particularly in Japan (down 10.9%).

Galvanic protection of steel has been the predominant end use of zinc in recent years and currently represents 47% of zinc consumption. Zinc is used extensively in the automotive and construction industries for corrosion protection and remains the most cost-effective means of protecting steel against corrosion. Zinc coatings act as a physical barrier and as an oxidant. The oxide, in turn, acts as a further barrier to corrosion.

The desire to reduce weight and improve fuel efficiency has led to increased use of galvanized steel in the automotive industry to protect the thinner gauges of steel from corrosion. In North America, the consumer trend towards all-purpose or sport utility vehicles has increased the consumption of zinc-coated automotive sheet. Both hot-dipped and electro-galvanized steel are used, the thicker coating of hot-dipped steel giving more corrosion protection to unexposed surfaces and the thinner coating of electro-galvanized steel providing a smoother finish for exposed painted surfaces.

Galvanized steel is also used in construction for structural components, roofing, siding and reinforcement bars. Nails and other building materials are often hot dip galvanized. Zinc and zinc-aluminum thermally sprayed coatings are used for the long-term corrosion protection of large steel structures such as bridges and hydro-electric transmission towers.

With the relatively high cost of lumber, fabricated hot-dipped structural steel is becoming cost-competitive for use in residential home construction. The number of steel-framed homes built yearly in the United States has risen steadily and was estimated at 250 000 in 1997. The U.S. steel industry hopes to capture 25% of the housing market (350 000 homes per year) by 2000, which would require 200 000 t/y of zinc.

Galvanized steel studs have a number of advantages over wood, including less volatile prices, less weight, immunity to warping or termites, fire resistance, and recyclability. However, disadvantages include their tendency to bend or dent if improperly handled and the need for specialized training and tools.

A number of zinc alloy coatings have been developed over the years with superior qualities over pure zinc in specific applications. These include Galfan (90% zinc, 5% aluminum and the remainder rare earth elements) and Galvalume (55% aluminum, 43.4% zinc and 1.6% silicon), as well as zinc-iron and zinc-nickel alloys. Galfan, for example, exhibits higher formability and paintability than other coatings, and zinc-nickel alloys reduce the reactivity of high-silicon steels.

Canada's hot-dip galvanized steel and Galvalume capacity of 1 902 000 t/y is located in Ontario at the facilities of Dofasco Inc. and Stelco Inc. in Hamilton and DNN Galvanizing Corporation in Windsor, and in Quebec at Sorevco in Coteau-du-Lac.

The manufacture of brass and bronze is the second most important use of zinc, accounting for 19% of consumption. The consumption of brass and bronze is highly dependent on the performance of the construction industry as these alloys are used in plumbing fittings, heating and air conditioning components, and other products. The addition of zinc to copper alloys improves their machinability, strength and resistance to corrosion.

The third most important use of zinc, accounting for 14% of consumption, is in zinc-based alloys for the creation of die-cast products such as builders' hardware and automobile fittings. The goal of weight reduction in automobiles for increased fuel efficiency has led to a reduction in the use of zinc die castings, although in the last few years zinc-based alloys have regained some of their former market share. The major reasons for this have been the development of direct injection die castings, the popularity of zinc-aluminum die-casting alloys, and diversification away from over-reliance on the automotive sector.

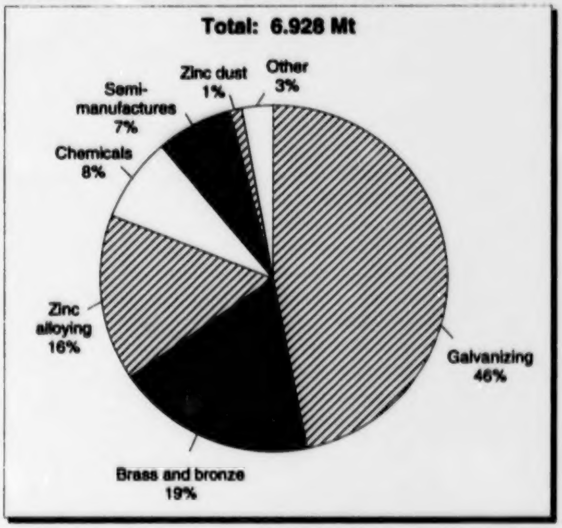
One promising series of alloys is ACuZinc, which contains 5-11% copper and 2.8-4.0% aluminum, with the balance being zinc. These alloys increase the durability and performance, and reduce the thickness, of automotive die castings compared to many other zinc alloys.

Zinc semi-manufactures represent about 8% of zinc consumption and include rolled zinc for roofing applications and the production of coinage. Rolled zinc roofing is especially popular in Europe.

The remainder of zinc consumption is for oxides and other chemicals and zinc dust. Zinc oxide has a variety of applications, the most important of which is as an accelerator in the curing of rubber. High-purity zinc oxide is used in the pharmaceutical industry, and zinc oxide-based salves and ointments have long been known for their healing properties. Other grades are used in the zinc plating industry, as an anti-corrosion agent in lubricants, and in paints, animal feeds and a variety of chemicals.

Zinc-air batteries are a promising development in the race to create viable electric vehicles. The zinc-air battery has a range three to four times that of comparatively sized lead-acid batteries. Its slow recharge time can be overcome by the introduction of replaceable cassettes that house a zinc anode and two cathodes that extract oxygen from air to fuel the chemical reaction. When removed, these cassettes can be taken to a regeneration facility where electrowinning cells turn zinc oxide back into zinc. Such a system is ideal for fleet vehicles that return to a centralized location each day, but for passenger vehicles the plan requires considerable infrastructure.

Figure 4
Western World Zinc Markets, 1998



Source: International Lead and Zinc Study Group.

Zinc-air batteries are being tested for use in electric vehicle fleets in Germany and Sweden. The Electric Power Research Institute (EPRI) in the United States agreed in June to introduce the zinc-air battery in North America. The EPRI will assess the performance, market acceptance and environmental impact of the battery, as well as the feasibility of establishing a zinc regeneration infrastructure in the United States.

International Lead and Zinc Study Group

The International Lead and Zinc Study Group (ILZSG) was formed in 1959 to improve market information and to provide opportunities for regular intergovernmental consultations on issues related to lead and zinc markets. Particular attention is given to providing regular and frequent information on supply, demand, and the outlook for lead and zinc.

The Study Group is headquartered in London, England. In 1998, 27 countries, representing most of the world's major lead- and zinc-producing and consuming nations, were members of the Group. While it has an extensive information-gathering and dissemination role, the Group has no market intervention powers. As well as being an effective mechanism for increasing market transparency related to production, consumption and trade for lead and zinc, the Group is an important forum for communication among governments, among industry, and between governments and industry. It holds a general session each year in October. Member countries' delegations include industry representatives as advisors. Canada has been an active member of the Group since its inception.

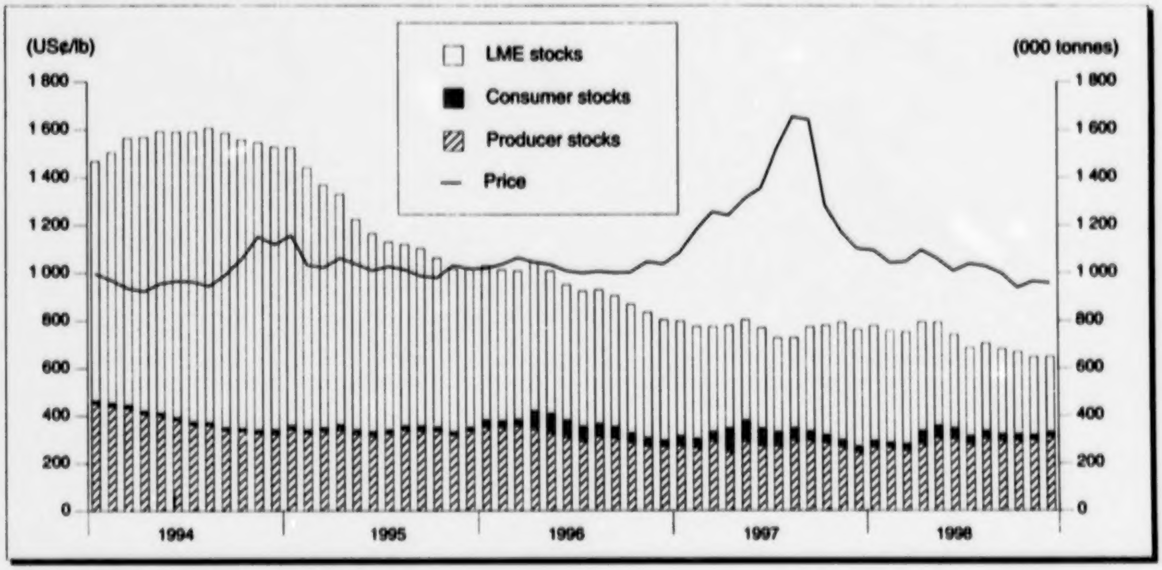
The 43rd Session of the Study Group was held in Marrakech, Morocco, in October 1998 and was attended by representatives of 25 member countries and observers from several nations and organizations. Canada hosted ILZSG's 7th International Recycling Conference in Toronto in May 1998. Entitled "Environmentally Friendly Lead and Zinc: The Challenge of the Recycling Millennium," the conference attracted some 150 participants, mainly from the business sector, with 25 countries represented. The conference examined the recycling of lead and zinc from the aspects of efficiency, competitiveness, and environmental responsibility towards the goal of sustainable development of metals.

Prices and Stocks

Zinc cash settlement prices on the LME peaked early in the year at US$1140/t (51.8¢/lb) followed by an overall downward trend to end the year at their lowest level of the year at US$916/t (41.5¢/lb). Zinc cash settlement prices overall averaged US$1023/t (46.4¢/lb), a decrease of about 22% from 1997. The forward three-month price averaged US$1046/t, with the market remaining in contango throughout the year.

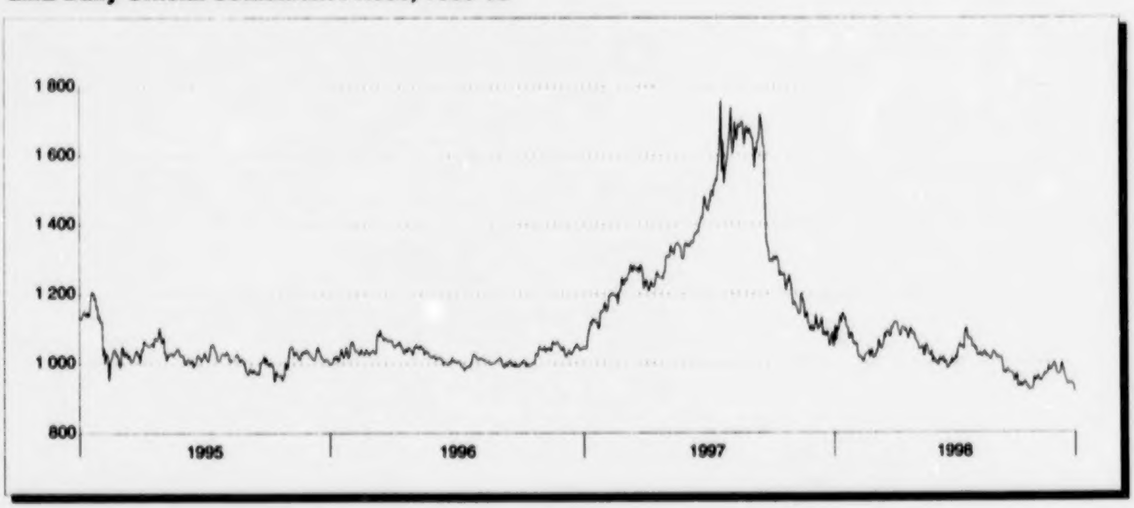
Changes in LME stock levels steadily declined throughout the year to finish at 317 000 t, or 175 000 t less than at the end of 1997. According to the ILZSG and in contrast to the sharp decline in LME stocks, stock levels reported by producers rose by 59 000 t in 1998 and peaked at 305 000 t by year-end.

Figure 5
LME Monthly Average Settlement Prices and Total Stocks, 1994-98



Source: International Lead and Zinc Study Group.

Figure 6
LME Daily Official Settlement Prices, 1995-98

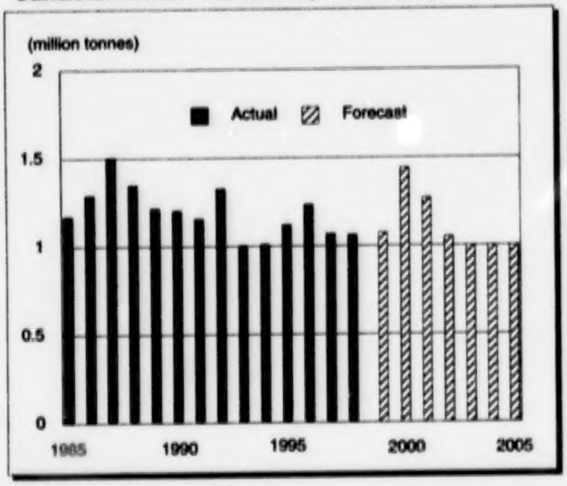


Source: Reuters.

Outlook

Canada's mine production of zinc is expected to increase 2% in 1999 as mines that opened late in 1998 complete a full year of production. Beyond 1999, production is predicted to remain at a level of between 1 300 000 and 1 400 000 t/y to the year 2001. Mine production is then expected to gradually decrease as ore reserves at older mines become exhausted, unless exploration, including that within existing mine infrastructures, leads to additional mineable reserves.

Figure 7
Canadian Mine Production, 1985-2005



Source: Natural Resources Canada.

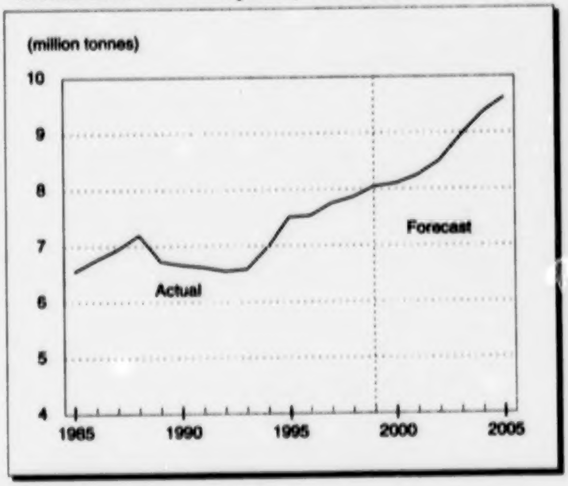
World zinc consumption is expected to increase 3% in 1999 to 7 990 000 t following the less than 1% increase in 1998. In 1999, the growth in North America (3.5%) and Europe (1.9%) is expected to continue with zinc demand expected to start to recover in Japan, South Korea and some Southeast Asian nations.

Zinc markets are expected to remain fairly balanced in 1999 with a slight deficit forecast overall. The continued market weakness in Japan and other Southeast Asian nations is expected to continue to exert a downward pressure on prices, at least for the first half of the year, averaging about US$1000/t (45¢/lb) for 1999.

Beyond 1999, investments made in the zinc industry in recent years are expected to result in large increases in mine and smelter capacity near the turn of the century. Continued growth in galvanizing markets, combined with a gradual recovery in overall markets, is expected in the remainder of the forecast period with zinc prices rising to US$1200-$1300/t (US55¢-60¢/lb) by 2005.

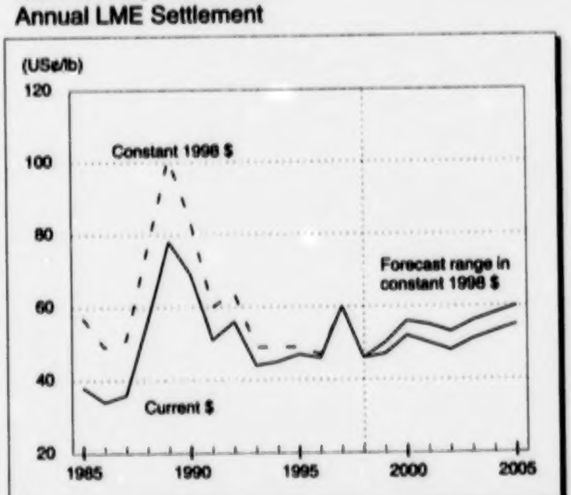
Notes: (1) For definitions and valuation of mineral production, shipments and trade, please refer to Chapter 65. (2) Information in this review was current as of April 6, 1999.

Figure 8
World Zinc Consumption, 1985-2005



Source: Natural Resources Canada.

Figure 9
Zinc Prices, 1985-2005
Annual LME Settlement



Source: Natural Resources Canada.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EU MFN	Japan[1] WTO
2603.00	Copper ores and concentrates						
2603.00.00.30	Zinc content	Free	Free	Free	Free	Free	Free
2607.00	Lead ores and concentrates						
2607.00.00.30	Zinc content	Free	Free	Free	Free	Free	Free
2608.00	Zinc ores and concentrates						
2608.00.00.30	Zinc content	Free	Free	Free	Free	Free	Free
2616.10	Silver ores and concentrates						
2616.10.00.30	Zinc content	Free	Free	Free	Free	Free	Free
26.20	Ash and residues (other than from the manufacture of iron or steel) containing metals or metal compounds containing mainly zinc						
2620.11	Hard zinc spelter	Free	Free	Free	Free	Free	Free
2817.00	Zinc oxide; zinc peroxide	Free	Free	Free	Free	8.8%	4.5%
28.33	Sulphates; alums; peroxosulphates (persulphates)						
2833.26	Of zinc	Free	Free	Free	Free	6.2%	4%
79.01	Unwrought zinc						
	Zinc, not alloyed:						
7901.11	Containing by weight 99.99% or more of zinc	Free	Free	Free	Free	2.5%	5.04 yen/kg
7901.12	Containing by weight less than 99.99% of zinc	Free	Free	Free	Free	2.5%	5.04 yen/kg
7901.20	Zinc alloys:						
7901.20.00.10	Containing by weight 90% or more but less than 97.5% of zinc	Free	Free	Free	Free	2.5%	5 yen/kg
7901.20.00.20	Containing by weight less than 90% of zinc	Free	Free	Free	Free	2.5%	Free-5 yen/kg
7902.00	Zinc waste and scrap	Free	Free	Free	Free	Free	0.4%
79.03	Zinc dust, powders and flakes						
7903.10	Zinc dust	Free	Free	Free	Free	2.9%	3.6%
7903.90	Other:	Free	Free	Free	Free	2.9%	3.6%
7904.00	Zinc bars, rods, profiles and wires	Free	Free	Free	Free	5.6%	3.4%
7905.00	Zinc plates, sheets, strip and foil	Free	Free	Free	Free	5.6%	3.8%
7906.00	Zinc tubes, pipes, and tube or pipe fittings (for example, couplings, elbows, sleeves)	3%	Free	Free	Free	5.6%	3.4%
7907.00	Other articles of zinc						
7907.00.10	Anodes for electroplating	Free	Free	Free	Free	5.4%	3.6%
7907.00.20	Discs or slugs, containing by weight 90% or more of zinc; gutters, roof capping, skylight frames and other fabricated building components	3%	Free	Free	Free	5.4 %	3.6%
7907.00.90	Other	3%	3%	Free	Free	5.4%	3.6%

Sources: Customs Tariff, effective January 1999, Revenue Canada; Harmonized Tariff Schedule of the United States, 1999; Worldtariff Guidebook on Customs Tariff Schedules of Import Duties of the European Union (38th Annual Edition: 1998); Customs Tariff Schedules of Japan, 1998.

[1] WTO rate is shown; lower tariff rates may apply circumstantially.

Note: Where there is a tariff "range," a complete match of the HS code was not available; therefore, the high and low for the product in question are shown.

TABLE 1. CANADA, ZINC PRODUCTION AND TRADE, 1997 AND 1998, AND CONSUMPTION, 1995-97

Item No.		1997		1998[p]	
		(tonnes)	($000)	(tonnes)	($000)
PRODUCTION					
	All forms[1]				
	New Brunswick	270 240	492 378	285 233	429 561
	Northwest Territories	169 928	309 609	177 825	267 805
	Quebec	190 276	346 683	165 059	248 579
	British Columbia	159 152	289 975	153 612	231 340
	Ontario	116 692	212 612	95 890	144 411
	Manitoba	81 518	148 526	94 757	142 704
	Yukon	39 057	71 163	14 984	22 566
	Total	1 026 864	1 870 946	987 361	1 486 966
	Mine output[2]	1 076 385	. .	1 057 011	. .
	Refined[3]	703 798	. .	743 623	. .
EXPORTS					
2608.00.30	Zinc content in zinc ores and concentrates				
	Sweden	43 800	101 700	47 868	73 295
	Germany	44 822	73 409	55 990	68 625
	Belgium	86 868[r]	87 664[r]	55 639	53 514
	Spain	97 545	90 767	52 692	43 296
	Finland	27 294	63 806	27 501	40 039
	Japan	39 068	37 650	49 618	36 985
	Italy	38 686	46 147	21 789	21 190
	Norway	23 826	36 394	17 708	18 975
	Other countries	87 264[r]	84 062[r]	62 327	54 124
	Total	489 373[r]	621 599[r]	391 132	410 043
2600.00	Zinc content in other ores and concentrates[4]	324	25	–	–
2603.00.30	Zinc content in copper	–	–	–	–
2607.00.30	Zinc content in lead	324	25	–	–
2616.10.30	Zinc content in silver	–	–	–	–
2620.11	Ash and residues containing hard zinc spelter				
	United States	82	274	88	151
	Total	82	274	88	151
2620.19	Ash and residues containing mainly zinc, n.e.s.				
	United States	10 370[r]	9 947[r]	9 046	9 461
	India	165[r]	178[r]	99	100
	Other counties	95[r]	89[r]	52	70
	Total	10 630[r]	10 214[r]	9 197	9 631
2817.00	Zinc oxide; zinc peroxide				
	United States	33 003	60 855	32 952	53 922
	France	118	199	162	271
	Hong Kong	54	117	108	190
	Germany	493	565	20	24
	Japan	160	357	–	–
	Other countries	129	235	81	122
	Total	33 957	62 328	33 323	54 529
2833.26	Zinc sulphate				
	United States	59	164	206	169
	Total	59	164	206	169
7901.11	Zinc, not alloyed, unwrought, containing by weight 99.99% or more of zinc				
	United States	342 421[r]	645 088[r]	320 321	537 422
	Taiwan	9 124	17 087	10 505	16 898
	Indonesia	8 625	17 210	6 009	10 016
	Philippines	9 029	17 197	4 849	8 138
	Hong Kong	4 251	8 438	4 556	7 673
	Japan	6 193	11 320	4 420	7 237
	Singapore	1 266	2 308	2 364	3 818
	Malaysia	3 699	6 761	2 192	3 765
	Kenya	1 158	2 104	479	714
	Other countries	1 149	2 132	1 887	2 885
	Total	386 915[r]	729 645[r]	357 582	598 566

TABLE 1 (cont'd)

Item No.		1997 (tonnes)	1997 ($000)	1998p (tonnes)	1998p ($000)
EXPORTS (cont'd)					
7901.12	Zinc, not alloyed, unwrought, containing by weight less than 99.99% of zinc				
	United States	128 803r	237 349r	185 487	314 744
	Hong Kong	2 684	5 516	6 120	11 365
	Philippines	4 886	10 012	5 221	8 413
	Japan	5 180	10 554	4 911	8 309
	Taiwan	7 674	14 872	4 889	8 090
	New Zealand	4 036	7 286	5 343	8 062
	Indonesia	3 580	6 849	1 575	2 651
	Other countries	3 206	6 993	5 798	10 570
	Total	160 049r	299 431r	219 344	372 204
7901.20	Zinc alloys, unwrought				
	United States	27	63	381	676
	Other countries	21r	37r	–	–
	Total	48	100	381	676
7902.00	Zinc waste and scrap				
	United States	26 276	18 159	26 635	22 366
	Taiwan	699	849	210	244
	India	161	130	195	206
	Other countries	159r	139r	59	24
	Total	27 295r	19 277r	27 099	22 840
7903.10	Zinc dust				
	United States	5 344	13 555	5 319	12 527
	Total	5 344	13 555	5 319	12 527
7903.90	Zinc powders and flakes				
	United States	2 604	7 424r	6 492	17 951
	Other countries	297	542	106	198
	Total	2 901	7 966r	6 598	18 149
7904.00	Zinc bars, rods, profiles and wire				
	United States	102	461	107	496
	Other countries	–	–	–	–
	Total	102	461	107	496
7905.00	Zinc plates, sheets, strip and foil				
	United States	59	508	73	324
	Total	59	508	73	324
7906.00	Zinc tubes, pipes and tube or pipe fittings (for example, couplings, elbows, sleeves)				
	United States	759	6 869	850	8 358
	Other countries	–	–	2	19
	Total	759	6 869	852	8 377
7907.00	Other articles of zinc				
	United States	2 802	16 406	2 032	16 929
	Other countries	38	204	29	261
	Total	2 840	16 610	2 061	17 190
IMPORTS					
2608.00.00.30	Zinc content in zinc ores and concentrates	187 547r	165 232r	210 495	129 035
2603.00.00.30	Zinc content in copper ores and concentrates	–	–	3	2
2607.00.00.30	Zinc content in lead ores and concentrates	699	614	269	443
2616.10.00.30	Zinc content in silver ores and concentrates	12 474	11 147	14 179	11 834
2620.11	Ash and residues containing hard zinc spelter	–	–	–	–
2620.19	Ash and residues containing mainly zinc, n.e.s.	375	289	1 963	2 103
2817.00	Zinc oxide; zinc peroxide	7 256	9 040r	4 420	5 896
2833.26	Zinc sulphate	3 707	2 602	4 336	3 199
7901.11	Zinc, not alloyed, unwrought, containing by weight 99.99% or more of zinc	6 072r	10 011r	2 072	2 783
7901.12	Zinc, not alloyed, unwrought, containing by weight less than 99.99% of zinc	1 144	1 737r	1 364	2 095
7901.20	Zinc alloys, unwrought	11 874r	22 533r	10 312	20 347

TABLE 1 (cont'd)

Item No.		1997 (tonnes)	1997 ($000)	1998[p] (tonnes)	1998[p] ($000)
IMPORTS (cont'd)					
7902.00	Zinc waste and scrap	2 233	2 209	680	710
7903.10	Zinc dust	3 532	6 839	2 334	4 935
7903.90	Zinc powders and flakes	522	1 114[r]	375	686
7904.00	Zinc bars, rods, profiles and wire	2 387	4 930	3 770	6 937
7905.00	Zinc plates, sheets, strip and foil	1 528[r]	5 347[r]	1 492	4 679
7906.00	Zinc tubes, pipes and tube or pipe fittings (for example, couplings, elbows, sleeves)	1 431[r]	7 371[r]	1 549	11 067
7907.00	Other articles of zinc	5 294[r]	21 373[r]	6 065	24 442
	Total Imports	248 075[r]	273 388[r]	265 678	231 193

	1995			1996[*]			1997[p*]		
	Primary	Secondary	Total	Primary	Secondary	Total	Primary	Secondary	Total
					(tonnes)				
CONSUMPTION[5,6]									
Zinc used for or in the production of:									
Copper alloys (brass, bronze, etc.)	x	x	3 402	x	x	3 018	x	x	2 717[r]
Galvanizing: electro	x	x	1 923	x	x	2 159	x	x	2 349
hot dip	x	x	72 419	x	x	79 047	x	x	77 034
Zinc die-cast alloys	x	x	28 973[r]	x	x	25 229[r]	x	x	22 924
Other products (including rolled and ribbon zinc, zinc oxides)	x	x	26 198[r]	x	x	27 514[r]	x	x	30 706
Total	130 770[r]	2 145	132 915[r]	132 439[r]	4 528[r]	136 967[r]	133 212[r]	2 518	135 730[r]
Consumer stocks, year-end	8 515[r]	60	8 576[r]	7 595[r]	292[r]	7 887[r]	10 133	65	10 198

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; n.e.s. Not elsewhere specified; [p] Preliminary; [r] Revised; x Confidential.
[*] Increase in number of companies being surveyed.
[1] New refined zinc produced from domestic primary materials (concentrates, slags, residues, etc.) plus estimated recoverable zinc in ores and concentrates shipped for export. [2] Zinc content of ores and concentrates produced. [3] Refined zinc produced from domestic and imported ores. [4] Includes HS classes 2603.00.30, 2607.00.30 and 2616.10.30. [5] Consumer survey does not represent 100% of Canadian consumption and is therefore consistently less than apparent consumption. [6] Due to sensitivity in some end-use categories, a breakdown of primary and secondary sources is not provided in order to be consistent.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, ZINC PRODUCTION AND EXPORTS,[1] 1975, 1980 AND 1986-98

	Production		Exports		
	All Forms[2]	Refined[3]	In Ores and Concentrates	Refined	Total
			(tonnes)		
1975	1 055 151	426 902	705 088	247 474	952 562
1980	883 697	591 565	434 178	471 949	906 127
1986	988 173	570 981	450 249	427 176	877 425
1987	1 157 936	609 909	613 185	441 227	1 054 412
1988	1 370 000	703 206	816 885	551 521	1 368 406
1989	1 272 854	669 677	614 223	495 061	1 109 284
1990	1 179 372	591 786	716 185	452 251	1 168 436
1991	1 083 008	660 552	566 815	520 508	1 087 323
1992	1 195 736	671 702	678 172	509 744	1 187 916
1993	990 727	659 881	455 953	493 264	949 217
1994	976 309	690 965	450 320	551 168	1 001 488
1995	1 094 703	720 346	609 575	533 179	1 142 754
1996	1 162 720	716 467	670 789[r]	581 604	1 252 393[r]
1997	1 026 864[r]	703 798[r]	489 697[r]	546 964[r]	1 036 661[r]
1998[p]	987 361	743 623	391 132	576 926	968 058

Sources: Natural Resources Canada; Statistics Canada.
[p] Preliminary; [r] Revised.
[1] Beginning in 1988, exports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Ores and concentrates include HS classes 2608.00.30, 2603.00.30, 2607.00.30 and 2616.10.30. Refined includes HS classes 7901.11 and 7901.12. [2] New refined zinc produced from domestic primary materials (concentrates, slags, residues, etc.) plus estimated recoverable zinc in ores and concentrates shipped for export. [3] Refined zinc produced from domestic and imported ores.

TABLE 3. WESTERN WORLD, PRIMARY ZINC STATISTICS, 1994-98

	1994	1995	1996	1997	1998p
			(000 tonnes)		
Mine production (zinc content)	5 172	5 341	5 564	5 498	5 594
Metal production	5 375	5 463	5 496	5 566	5 715
Metal consumption	5 862	6 261	6 225	6 416	6 480

Source: International Lead and Zinc Study Group.
p Preliminary.

TABLE 4. WORLD MINE PRODUCTION OF ZINC, 1994-98

	1994	1995	1996	1997	1998p
			(000 tonnes)		
EUROPE					
Finland	17	16	27	32	31
Ireland	194	184	163	193	163
Poland	151	155	159	158	156
Russia	147	131	126	121	120
Spain	151	172	140	147	128
Sweden	160	169	160	155	167
Others	150	142	122	130	114
Subtotal	970	969	897	936	879
AFRICA					
Morocco	79	80	82	91	108
Namibia	33	30	35	37	42
South Africa	76	74	77	71	70
Others	17	50	38	6	–
Subtotal	205	234	232	209	253
OCEANIA					
Australia	928	882	1 008	972	1 013
AMERICAS					
Bolivia	101	146	145	155	147
Brazil	146	136	128	124	88
Canada	1 011	1 121	1 223	1 077	1 063
Mexico	381	364	378	379	370
Peru	690	692	761	865	869
United States	598	644	628	632	728
Others	81	94	103	103	85
Subtotal	3 008	3 197	3 366	3 335	3 350
ASIA					
China	990	1 011	1 121	1 210	1 200
India	147	154	154	142	176
Iran	75	78	76	77	80
Japan	101	95	79	72	68
Kazakstan	152	155	157	223	240
North Korea	90	90	80	60	48
Thailand	59	14	19	15	25
Turkey	34	65	68	64	60
Others	53	37	38	29	33
Subtotal	1 701	1 699	1 792	1 892	1 930
Total world	6 812	6 981	7 295	7 344	7 425
Total Western World	5 172	5 341	5 564	5 498	5 594

Source: International Lead and Zinc Study Group.
– Nil; p Preliminary.

TABLE 5. WORLD ZINC METAL PRODUCTION, 1994-98

	1994	1995	1996	1997	1998p
			(000 tonnes)		
EUROPE					
Belgium	211	211	207	203	205
Finland	173	177	179	176	199
France	309	314	324	317	321
Germany	360	322	328	318	334
Italy	256	260	269	268	232
Netherlands	212	208	207	201	218
Norway	137	131	135	136	138
Poland	158	165	165	173	175
Russia	138	166	172	189	196
Spain	296	364	363	378	370
Others	261	265	299	296	275
Subtotal	2 511	2 583	2 648	2 655	2 663
AFRICA					
Algeria	24	27	30	30	30
South Africa	94	99	101	110	112
Others	1	–	–	–	–
Subtotal	119	126	131	140	142
AMERICAS					
Argentina	35	36	36	39	38
Brazil	199	194	187	186	175
Canada	691	720	716	704	743
Mexico	209	223	222	230	233
Peru	161	159	173	174	184
United States	356	363	366	367	386
Subtotal	1 651	1 695	1 700	1 700	1 759
ASIA					
China	1 017	1 077	1 185	1 434	1 419
India	157	159	149	166	177
Japan	666	664	599	603	608
Kazakstan	172	169	169	185	242
North Korea	100	100	90	55	45
South Korea	271	279	287	336	390
Others	149	150	147	188	188
Subtotal	2 532	2 598	2 626	2 967	3 069
OCEANIA					
Australia	318	322	327	307	311
Total world	7 131	7 324	7 432	7 769	7 944
Total Western World	5 375	5 463	5 496	5 566	5 715

Source: International Lead and Zinc Study Group.
– Nil; p Preliminary.

TABLE 6. WORLD ZINC CONSUMPTION, 1994-98

	1994	1995	1996	1997	1998p
			(000 tonnes)		
EUROPE					
Belgium	225	250	235	260	260
France	241	271	248	271	294
Germany	519	505	480	507	525
Italy	320	345	336	354	377
Russia	114	130	130	146	130
Spain	140	159	150	160	182
United Kingdom	206	224	226	224	219
Others	552	600	603	632	662
Subtotal	2 317	2 484	2 408	2 554	2 649
AFRICA					
South Africa	92	95	95	98	105
Others	55	61	60	57	61
Subtotal	147	156	155	155	166
OCEANIA					
Australia	173	180	177	176	178
New Zealand	22	20	20	20	21
Subtotal	195	200	197	196	199
AMERICAS					
Brazil	151	179	185	190	186
Canada	147	149	151	158	169
Mexico	132	119	152	178	186
United States	1 176	1 234	1 214	1 257	1 295
Others	138	138	151	159	161
Subtotal	1 744	1 819	1 853	1 942	1 997
ASIA					
China	655	750	829	830	885
India	192	202	214	220	231
Japan	721	752	736	746	659
South Korea	318	350	364	343	318
Taiwan	170	205	194	225	241
Others	520	595	589	544	518
Subtotal	2 576	2 854	2 926	2 908	2 852
Total world	6 979	7 513	7 539	7 755	7 863
Total Western World	5 862	6 261	6 225	6 416	6 480

Source: International Lead and Zinc Study Group.
p Preliminary.

TABLE 7. CANADA, ZINC METAL CAPACITY, 1998

Company and Location	Annual Rated Capacity
	(000 tonnes of slab zinc)
PRIMARY	
Canadian Electrolytic Zinc Limited Valleyfield, Quebec	250
Falconbridge Limited Timmins, Ontario	133
Hudson Bay Mining and Smelting Co., Limited Flin Flon, Manitoba	95
Cominco Ltd. Trail, British Columbia	290
Total primary, Canada	768

Source: Natural Resources Canada.

TABLE 8. MONTHLY AVERAGE ZINC PRICES, 1997 AND 1998

	North American Special High Grade	LME Special High Grade Settlement
	(US¢/lb)	(US$/t)
1997		
January	55.2	1 086.5
February	59.3	1 179.4
March	62.7	1 254.8
April	62.0	1 240.4
May	64.9	1 310.5
June	66.1	1 354.2
July	73.3	1 518.0
August	79.1	1 653.5
September	78.5	1 640.9
October	62.1	1 280.1
November	57.4	1 173.0
December	54.2	1 101.7
Yearly average	64.6	1 316.1
1998		
January	54.0	1 096.7
February	51.5	1 043.6
March	51.8	1 047.2
April	54.4	1 096.6
May	53.6	1 060.8
June	51.1	1 009.5
July	52.7	1 039.8
August	52.1	1 029.4
September	50.6	1 000.0
October	47.9	940.1
November	49.0	966.8
December	48.5	958.8
Yearly average	51.4	1 024.1

Sources: *Metals Week;* Reuters.

Statistical Report

This statistical summary of the Canadian mineral industry has been compiled by staff of the Minerals and Mining Statistics Division, Minerals and Metals Sector, Natural Resources Canada (NRCan), under the general direction of Yvan Gauthier, Director.

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Statistics contained in this summary are obtained from a variety of sources. Principal sources include the statistical survey programs of NRCan, Statistics Canada, and Labour Canada. The statistical survey program of the Minerals and Mining Statistics Division of NRCan is conducted jointly with the provincial governments and Statistics Canada in order to minimize the reporting burden on the mineral industry. The cooperation of the companies providing information is greatly appreciated.

***(Note to Reader:** We continue to review the tables of this Report in order to establish the requirements of users. We would appreciate your feedback on which tables are important to you. Please contact Laurie Morrison at tel. (613) 992-6767 or e-mail lmorriso@nrcan.gc.ca to provide your input.)*

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TABLE 1. MINERAL PRODUCTION OF CANADA, 1995-98p

	Unit	1995		1996		1997		1998p	
	(000)	(Quantity)	($000)	(Quantity)	($000)	(Quantity)	($000)	(Quantity)	($000)
METALS									
Antimony	kg	574	3 959	1 380	6 084	529	1 610	554	1 301
Bismuth	kg	159	1 815	150	1 598	196	1 956	217	2 431
Cadmium	kg	1 686	9 383	1 540	5 732	1 272	1 991	1 384	1 323
Calcium	kg	x	x	x	x	x	x	x	x
Cesium, pollucite	kg	x	x	x	x	x	x	x	x
Cobalt	kg	2 016	176 921	2 150	164 918	2 168	154 408	2 324	167 696
Columbium (niobium)	kg	x	x	x	x	2 253	x	2 200	x
Copper	kg	700 842	2 818 090	652 499	2 059 285	647 779	2 050 869	688 576	1 693 209
Gold	g	150 867	2 557 502	164 660	2 799 547	171 479	2 527 429	166 089	2 322 417
Ilmenite	t	x	x	x	x	x	x	x	x
Indium	g	x	x	x	x	x	x	x	x
Iron ore	t	36 628	1 291 474	34 400	1 321 727	38 928	1 571 741	38 908	1 584 146
Iron remelt	t	x	x	x	x	x	x	x	x
Lead	kg	204 226	176 656	241 751	254 584	170 847	147 612	151 708	118 029
Lithium	kg	x	x	x	x	x	x	x	x
Magnesium	kg	x	x	x	x	x	x	x	x
Molybdenum	kg	9 113	202 931	8 789	100 196	7 594	87 582	7 563	82 438
Nickel	kg	172 107	2 031 727	182 404	1 920 348	180 624	1 775 898	200 908	1 419 416
Platinum group	g	16 068	181 996	13 934	141 620	11 836	134 242	14 522	222 883
Selenium	kg	561	8 317	694	7 140	592	5 045	384	2 839
Silver	kg	1 245	285 136	1 243	282 510	1 194	260 024	1 115	293 468
Tantalum	kg	40	3 965	67	7 625	60	7 230	74	10 394
Tellurium	kg	102	2 074	59	1 744	59	831	57	860
Uranium	kg	10 236	526 448	11 348	620 880	11 127	553 900	9 964	x
Zinc	kg	1 094 701	1 549 004	1 162 720	1 625 482	1 026 864	1 870 946	987 361	1 486 966
Total metals			12 172 744		11 697 468		11 549 178		10 318 910
NONMETALS									
Asbestos	t	516	234 730	506	256 722	420	214 910	320	167 200
Barite	t	61	6 556	58	6 498	84	7 119	80	7 329
Diamonds	carats	–	–	–	–	–	–	278	53 425
Gemstones	kg	459	1 420	294	684	407	1 482	131	416
Graphite	t	x	x	x	x	x	x	x	x
Gypsum	t	8 055	88 417	8 202	85 415	8 628	95 263	8 095	87 972
Magnesitic dolomite	t	x	x	x	x	x	x	x	x
Marl	t	x	x	x	x	x	x	x	x
Mica	t	x	x	x	x	x	x	x	x
Nepheline syenite	t	617	37 098	606	46 690	648	51 319	617	50 190
Peat	t	866	139 154	901	141 019	1 054	146 404	1 127	169 747
Potash	t	8 855	1 424 344	8 120	1 277 860	9 235	1 528 341	8 969	1 666 978
Potassium sulphate	t	x	x	x	x	x	x	x	x
Pumice	t	x	x	x	x	x	x	x	x
Quartz	t	1 689	38 409	1 558	36 193	1 690	40 198	1 700	40 527
Salt	t	10 957	270 369	12 248	359 818	13 497	405 509	13 192	399 520
Serpentine	t	x	x	x	x	x	x	x	x
Soapstone, talc and pyrophyllite	t	108	16 243	77	15 151	72	14 908	74	15 471
Sodium sulphate	t	315	25 377	323	30 964	285	29 040	277	28 473
Sulphur, elemental	t	7 846	187 685	8 327	83 805	8 272	84 129	8 410	54 321
Sulphur in smelter gas	t	886	62 577	789	57 765	800	59 462	838	58 315
Titanium dioxide	t	x	x	x	x	x	x	x	x
Tremolite	t	x	x	x	x	x	x	–	–
Zeolite	t	x	x	x	x	x	x	x	x
Total nonmetals			2 906 085		2 765 775		3 026 971		3 277 231
MINERAL FUELS									
Coal	t	74 920	1 834 630	75 860	1 936 050	78 670	1 920 150	74 370	1 793 230
Natural gas	000 m^3	148 202	6 830 779	153 578	8 734 860	156 171	10 719 153	161 015	11 195 954
Natural gas by-products	m^3	25 040	1 772 424	26 657	2 838 702	26 427	2 599 598	26 612	1 790 640
Crude oil and equivalent	m^3	114 372	15 321 005	117 621	19 071 725	123 827	17 837 834	128 769	12 990 337
Total fuels			25 758 838		32 581 337		33 076 735		27 770 161
STRUCTURAL MATERIALS									
Clay products	$	. .	95 634	. .	110 218	. .	136 324	. .	135 319
Cement	t	10 440	842 492	11 587	964 380	11 736	1 062 708	12 064	1 126 875
Lime	t	2 462	206 933	2 402	202 579	2 477	213 038	2 514	220 509
Sand and gravel	t	225 991	793 489	213 831	772 590	225 495	829 190	217 650	819 893
Stone	t	96 578	591 255	92 331	592 547	99 265	644 162	95 998	646 198
Total structural materials			2 529 804		2 642 314		2 88[illegible] 421		2 948 794
Total all minerals			43 367 470		49 686 893		50 538 306		44 315 096

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; p Preliminary; x Confidential.
Notes: Numbers may not add to totals due to rounding. Confidential values are included in totals.

TABLE 2. CANADA, VALUE OF MINERAL PRODUCTION, PER CAPITA VALUE OF MINERAL PRODUCTION, AND POPULATION, 1972-98

Year	Value of Mineral Production					Per Capita Value of Mineral Production	Population of Canada
	Metals	Nonmetals	Structural Materials	Fuels	Total		
	($ millions)					($)	(000)
1972	3 037	514	571	2 368	6 490	291.23	22 285
1973	3 947	615	678	3 227	8 467	375.31	22 560
1974	4 934	896	835	5 202	11 867	518.78	22 875
1975	5 022	939	959	6 653	13 574	584.86	23 209
1976	5 344	1 166	1 107	8 109	15 726	668.68	23 518
1977	6 031	1 363	1 249	9 873	18 516	778.11	23 796
1978	5 746	1 481	1 508	11 578	20 313	845.11	24 036
1979	8 006	1 870	1 646	15 117	26 638	1 097.25	24 277
1980	9 777	2 531	1 624	17 944	31 875	1 296.10	24 593
1981	8 841	2 714	1 777	19 046	32 378	1 300.32	24 900
1982	6 953	2 105	1 736	23 038	33 831	1 342.39	25 202
1983	7 528	2 021	1 836	27 154	38 539	1 513.95	25 456
1984	8 897	2 538	1 955	30 399	43 789	1 703.72	25 702
1985	8 745	2 736	2 128	31 120	44 730	1 724.23	25 942
1986	8 819	2 523	2 341	18 763	32 446	1 238.21	26 204
1987	10 962	2 381	2 744	20 274	36 361	1 369.53	26 550
1988	13 608	2 757	2 817	17 773	36 955	1 374.05	26 895
1989	13 982	2 706	2 860	19 785	39 333	1 436.61	27 379
1990	12 500	2 529	2 760	22 990	40 778	1 467.31	27 791
1991	10 462	2 407	2 376	19 945	35 190	1 251.42	28 120
1992	10 210	2 239	2 234	20 901	35 584	1 246.72	28 542
1993	8 871	2 147	2 312	23 214	36 545	1 262.48	28 947
1994	9 750	2 648	2 544	26 243	41 185	1 418.41	29 036
1995	12 173	2 906	2 530	25 759	43 367	1 477.38	29 354
1996	11 697	2 766	2 642	32 581	49 687	1 674.54	29 672
1997	11 549	3 027	2 885	33 077	50 538	1 683.98	30 011
1998p	10 319	3 277	2 949	27 770	44 315	1 462.49	30 301

Sources: Natural Resources Canada; Statistics Canada.
p Preliminary.
Notes: Beginning in 1986, bentonite, diatomite and sodium antimonate are reported in industrial minerals. Numbers may not add to totals due to rounding.

TABLE 3. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCE, TERRITORY AND MINERAL CLASS, 1998p

Province/Territory	Metals		Nonmetals		Structural Materials		Mineral Fuels		Total	
	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)
Alberta	–	–	115 046	3.5	400 975	13.6	21 677 757	78.1	22 193 778	50.1
Ontario	3 272 001	31.7	383 839	11.7	1 337 897	45.4	65 729	0.2	5 059 466	11.4
Saskatchewan	538 566	5.2	1 634 173	49.9	36 022	1.2	2 448 965	8.8	4 657 727	10.5
British Columbia	1 463 590	14.2	49 675	1.5	404 257	13.7	2 568 958	9.3	4 486 481	10.1
Quebec	2 192 194	21.2	711 092	21.7	539 240	18.3	–	–	3 442 526	7.8
Manitoba	825 630	8.0	21 921	0.7	61 481	2.1	76 822	0.3	985 855	2.2
Newfoundland	962 414	9.3	432	. . .	38 735	1.3	454 876	1.6	1 456 456	3.3
New Brunswick	602 521	5.8	186 457	5.7	40 150	1.4	23 090	0.1	852 218	1.9
Northwest Territories	348 531	3.4	53 425	1.6	4 948	0.2	172 433	0.6	579 338	1.3
Nova Scotia	–	–	119 924	3.7	81 152	2.8	263 836	1.0	464 912	1.0
Yukon	113 463	1.1	–	–	2 932	0.1	17 695	0.1	134 090	0.3
Prince Edward Island	–	–	1 245	. . .	1 006	. . .	–	–	2 251	. . .
Total	10 318 910	100.0	3 277 231	100.0	2 948 794	100.0	27 770 161	100.0	44 315 096	100.0

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . . Amount too small to be expressed; p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 4. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCE, TERRITORY AND MINERAL CLASS, 1997

Province/Territory	Metals		Nonmetals		Structural Materials		Mineral Fuels		Total	
	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)
Alberta	176	. . .	133 090	4.4	382 939	13.3	26 155 080	79.1	26 671 286	52.8
Ontario	3 841 788	33.3	399 329	13.2	1 295 023	44.9	78 822	0.2	5 614 963	11.1
Saskatchewan	614 847	5.3	1 440 389	47.6	36 862	1.3	3 416 324	10.3	5 508 422	10.9
British Columbia	1 495 315	12.9	46 888	1.5	397 854	13.8	2 741 265	8.3	4 681 322	9.3
Quebec	2 288 106	19.8	616 272	20.4	532 669	18.5	–	–	3 437 046	6.8
Manitoba	940 926	8.1	18 926	0.6	60 722	2.1	105 137	0.3	1 125 710	2.2
Newfoundland	966 218	8.4	386	. . .	41 668	1.4	29 900	0.1	1 038 173	2.1
New Brunswick	657 533	5.7	238 937	7.9	38 412	1.3	18 190	0.1	953 071	1.9
Northwest Territories	543 682	4.7	–	–	5 086	0.2	250 025	0.8	798 793	1.6
Nova Scotia	–	–	130 350	4.3	90 135	3.1	260 232	0.8	480 717	1.0
Yukon	200 587	1.7	–	–	3 045	0.1	21 760	0.1	225 392	0.4
Prince Edward Island	–	–	2 404	0.1	1 006	. . .	–	–	3 410	. . .
Total	11 549 178	100.0	3 026 971	100.0	2 885 421	100.0	33 076 735	100.0	50 538 306	100.0

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . . Amount too small to be expressed.
Note: Numbers may not add to totals due to rounding.

TABLE 5. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCE AND TERRITORY, 1991-98

Province/Territory	1991	1992	1993	1994	1995	1996	1997	1998p
	($ millions)							
Alberta	16 373	17 056	18 925	21 119	20 676	26 218	26 671	22 194
Ontario	5 101	4 776	4 534	4 921	5 825	5 718	5 615	5 059
Saskatchewan	2 863	3 158	3 238	4 225	4 580	5 331	5 508	4 658
British Columbia	3 840	3 500	3 538	4 066	4 501	4 340	4 681	4 486
Quebec	2 930	2 694	2 692	2 956	3 338	3 415	3 437	3 443
Manitoba	1 125	1 082	862	820	1 022	1 002	1 126	986
Newfoundland	671	706	699	837	878	906	1 038	1 456
New Brunswick	772	910	772	862	1 021	955	953	852
Northwest Territories	703	681	585	680	766	780	799	579
Nova Scotia	460	523	554	608	560	593	481	465
Yukon	349	496	141	86	196	425	225	134
Prince Edward Island	3	2	4	3	4	4	3	2
Total	35 190	35 584	36 545	41 185	43 387	49 687	50 538	44 315

Sources: Natural Resources Canada; Statistics Canada.
p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 6. CANADA, PRODUCTION OF LEADING MINERALS, 1997 AND 1998p

		Volume		Percent Change	Value		Percent Change
		1997	1998p	1998/1997	1997	1998p	1998/1997
		(000 tonnes except where noted)			($ millions)		
METALS							
Gold	kg	171 479	166 089	–3.1	2 527.4	2 322.4	–8.1
Copper		648	689	6.3	2 050.9	1 693.2	–17.4
Iron ore		38 928	38 908	–0.1	1 571.7	1 584.1	0.8
Zinc		1 027	987	–3.8	1 870.9	1 487.0	–20.5
Nickel		181	201	11.2	1 775.9	1 419.4	–20.1
Uranium	tU	11 127	9 984	–10.3	553.9	x	x
Silver	t	1 194	1 115	–6.6	260.0	293.5	12.9
Platinum group	kg	11 836	14 522	22.7	134.2	222.9	66.0
Cobalt	t	2 168	2 324	7.2	154.4	167.7	8.6
Lead		171	152	–11.2	147.6	118.0	–20.0
Molybdenum	t	7 594	7 563	–0.4	87.6	82.4	–5.9
NONMETALS							
Potash (K_2O equivalent)		9 235	8 969	–2.9	1 528.3	1 667.0	9.1
Salt		13 497	13 192	–2.3	405.5	399.5	–1.5
Peat		1 054	1 127	6.9	146.4	169.7	15.9
Asbestos		420	320	–23.8	214.9	167.2	–22.2
Gypsum		9 628	8 095	–6.2	95.3	88.0	–7.7
Sulphur in smelter gas		800	838	4.8	59.5	58.3	–1.9
Sulphur, elemental		8 272	8 410	1.7	84.1	54.3	–35.4
Diamonds	000 carats	–	278	n.a.	–	53.4	n.a.
Nepheline syenite		648	617	–4.8	51.3	50.2	–2.2
STRUCTURAL MATERIALS							
Cement		11 736	12 064	2.8	1 062.7	1 126.9	6.0
Sand and gravel		225 495	217 650	–3.5	829.2	819.9	–1.1
Stone		99 265	95 998	–3.3	644.2	646.2	0.3
Lime		2 477	2 514	1.5	213.0	220.5	3.5
Clay products		. .	. .	. .	136.3	135.3	–0.7
MINERAL FUELS							
Crude oil and equivalent	000 m^3	123 827	128 769	4.0	17 837.8	12 990.3	–27.2
Natural gas	million m^3	156 171	161 015	3.1	10 719.2	11 196.0	4.4
Coal		78 670	74 370	–5.5	1 920.2	1 793.2	–6.6
Natural gas by-products	000 m^3	26 527	26 612	0.7	2 599.2	1 790.6	–31.1

Sources: Natural Resources Canada; Statistics Canada, *Canada's Mineral Production, Preliminary Estimates*, cat. no. 26-202-XIB.
– Nil; . . Not available; n.a. Not applicable; p Preliminary; x Confidential.
Note: Numbers have been rounded.

TABLE 7. PRODUCTION OF LEADING MINERALS, BY PROVINCE AND TERRITORY IN CANADA, 1998p

	Unit	Nfld.	P.E.I.	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia	Yukon	N.W.T.	Total Canada
	(000)													
Petroleum, crude	m^3	3 883	–	1 015	–	–	217	645	23 199	94 857	3 303	–	1 851	128 770
	$	454 876	–	125 866	–	–	26 720	76 822	1 937 894	9 830 362	377 555	–	160 242	12 990 337
Natural gas	000 m^3	–	–	–	–	–	277	–	5 689	133 862	20 727	303	158	161 016
	$	–	–	–	–	–	39 009	–	377 224	9 616 941	1 132 894	17 695	12 191	11 195 954
Gold	g	1 392	–	–	266	37 966	84 028	x	x	–	21 734	5 705	3 846	166 065
	$	19 468	–	–	3 724	530 879	1 174 966	x	x	–	303 935	79 767	53 772	2 322 414
Coal	t	–	–	2 200	280	–	–	–	12 040	34 880	24 970	–	–	74 370
	$	–	–	137 970	23 090	–	–	–	126 430	519 000	986 740	–	–	1 793 230
Natural gas by-products	m^3	–	–	–	–	–	–	–	101	25 619	893	–	–	26 613
	$	–	–	–	–	–	–	–	7 417	1 711 454	71 769	–	–	1 790 640
Copper	kg	–	–	–	14 553	121 860	224 882	50 203	–	–	277 078	–	–	688 576
	$	–	–	–	35 786	299 653	552 987	123 449	–	–	681 333	–	–	1 693 208
Potash (K_2O equivalent)	t	–	–	–	x	–	–	–	x	–	–	–	–	8 968
	$	–	–	–	x	–	–	–	x	–	–	–	–	1 666 978
Iron ore	t	23 266	–	–	–	15 152	389	–	–	–	102	–	–	38 909
	$	942 794	–	–	–	x	x	–	–	–	2 177	–	–	1 584 146
Zinc	kg	–	–	–	285 234	165 059	95 891	94 757	–	–	153 613	14 984	177 825	987 363
	$	–	–	–	429 561	248 579	144 410	142 704	–	–	231 339	22 566	267 805	1 486 964
Nickel	kg	–	–	–	–	16 035	134 730	50 143	–	–	–	–	–	200 908
	$	–	–	–	–	113 287	951 870	354 259	–	–	–	–	–	1 419 416
Cement	t	x	–	x	–	2 629	5 427	–	–	x	1 883	–	–	12 065
	$	x	–	x	–	214 551	477 265	–	–	x	187 458	–	–	1 126 875
Sand and gravel	t	2 430	240	3 263	4 076	24 439	91 310	10 497	10 933	36 778	31 346	868	1 475	217 655
	$	11 762	1 006	13 926	x	67 881	342 556	x	x	154 459	148 223	2 932	3 816	819 894
Stone	t	2 056	–	5 768	3 175	28 609	45 307	4 183	–	537	6 124	–	244	96 003
	$	17 363	–	34 556	19 256	192 871	307 683	19 986	–	6 275	47 067	–	1 132	646 208
Uranium	kg	–	–	–	–	–	–	–	9 983	–	–	–	–	9 983
	$	–	–	–	–	–	–	–	x	–	–	–	–	x
Titanium dioxide	t	–	–	–	–	x	–	–	–	–	–	–	–	x
	$	–	–	–	–	x	–	–	–	–	–	–	–	x
Salt	t	–	–	x	x	x	8 315	–	702	1 053	–	–	–	13 192
	$	–	–	x	x	x	257 856	–	30 728	16 398	–	–	–	399 519
Silver	kg	1	–	–	254	161	178	39	0	–	451	15	15	1 114
	$	152	–	–	66 914	42 390	46 713	10 352	116	–	118 793	3 807	4 230	293 467
Iron, remelt	t	–	–	–	–	x	–	–	–	–	–	–	–	x
	$	–	–	–	–	x	–	–	–	–	–	–	–	x
Platinum group	g	–	–	–	–	–	x	x	–	–	–	–	–	14 523
	$	–	–	–	–	–	x	x	–	–	–	–	–	222 883
Lime	t	–	–	–	x	x	1 333	x	–	x	x	–	–	2 516
	$	–	–	–	x	x	108 792	x	–	x	x	–	–	220 508
Peat	t	2	11	x	394	310	–	x	x	222	–	–	–	1 128
	$	254	1 245	x	53 816	43 656	–	x	x	39 109	–	–	–	169 746
Cobalt	kg	–	–	–	–	113	1 714	497	–	–	–	–	–	2 324
	$	–	–	–	–	8 152	123 661	35 883	–	–	–	–	–	167 696
Asbestos	t	–	–	–	–	320	–	–	–	–	–	–	–	320
	$	–	–	–	–	167 200	–	–	–	–	–	–	–	167 200
Clay products	t	–	–	–	–	–	–	–	10	–	10	–	–	20
	$	x	–	x	–	x	101 602	–	x	x	x	–	–	135 319
Lead	kg	–	–	–	81 752	–	–	–	–	–	31 334	9 413	29 210	151 709
	$	–	–	–	63 603	–	–	–	–	–	24 377	7 323	22 725	118 028
Total leading minerals	$	1 456 280	2 251	393 326	842 358	3 318 336	4 876 776	961 266	4 617 801	22 134 241	4 335 171	134 090	525 913	43 597 808
Total all minerals	$	1 456 458	2 251	464 912	852 218	3 442 525	5 059 488	985 855	4 657 727	22 193 780	4 488 480	134 090	579 338	44 315 100
Leading minerals as a percentage of all minerals		100.0	100.0	84.60	98.80	96.40	96.40	97.50	99.10	99.70	96.60	100.0	90.80	98.40

Sources: Natural Resources Canada; Statistics Canada.
– Nil; p Preliminary; x Confidential.
Notes: Certain minerals are not included in leading minerals due to confidentiality constraints. Confidential values are included in "Total all minerals." Numbers may not add to totals due to rounding.

TABLE 8. CANADA'S WORLD ROLE AS A PRODUCER OF CERTAIN IMPORTANT MINERALS, 1997p

			Rank of Five Leading Countries				
		World	1	2	3	4	5
Potash (K_2O equivalent) (mine production)			**Canada**	C.I.S.	Germany	Israel	United States
	000 t	25 427	**8 989**	6 650	3 423	1 488	1 465
	% of world total		**35.4**	26.2	13.5	5.9	5.8
Uranium (U concentrates) (mine production)			**Canada**	Australia	Niger	Namibia	United States
	t	36 101	**12 020**	5 489	3 450	2 905	2 170
	% of world total		**33.3**	15.2	9.6	8.0	6.0
Asbestos (mine production)			C.I.S.	**Canada**	China	Brazil	Zimbabwe
	000 t	1 928	685	**455**	250	208	142
	% of world total		35.5	**23.6**	13.0	10.8	7.4
Sulphur, elemental (mine production)			United States	**Canada**	C.I.S.	Japan	Poland
	000 t	39 587	10 510	**8 272**	4 483	2 013	1 710
	% of world total		26.5	**20.9**	11.3	5.1	4.3
Nickel (mine production)			C.I.S.	**Canada**	New Caledonia	Australia	Indonesia
	000 t	1 087	235	**191**	137	123	72
	% of world total		21.6	**17.5**	12.6	11.4	6.6
Zinc (mine production)			China	**Canada**	Australia	Peru	United States
	000 t	7 426	1 210	**1 076**	1 036	865	632
	% of world total		16.3	**14.5**	14.0	11.7	8.5
Gypsum (mine production)			United States	**Canada**	China	Thailand	Iran
	000 t	104 617	18 600	**9 117**	7 800	8 600	8 500
	% of world total		17.8	**8.7**	7.5	8.2	8.1
Titanium concentrates (ilmenite, rutile, slag)			Australia	South Africa	**Canada**	Norway	India
	000 t	6 275e	2 500	1 100	**850**	750	316
	% of world total		39.8	17.5	**13.5**	11.8	5.0
Aluminum (primary metal)			United States	C.I.S.	**Canada**	China	Australia
	000 t	21 796	3 603	2 906	**2 327**	2 046	1 490
	% of world total		16.5	13.3	**10.7**	9.4	6.8
Copper (mine production)			Chile	United States	**Canada**	Australia	Indonesia
	000 t	11 450	3 392	1 940	**660**	560	548
	% of world total		29.6	16.9	**5.8**	4.9	4.8
Platinum group metals (mine production)			South Africa	C.I.S.	**Canada**	United States	Japan
	kg	287 389	192 400	67 500	**12 459**	11 010	2 580
	% of world total		66.9	23.5	**4.3**	3.8	0.9
Cobalt (shipments)			Zambia	Russia	Congo, D.R.	**Canada**	Cuba
	t	23 569	6 100	4 100	3 500	**2 168**	2 100
	% of world total		25.9	17.4	14.9	**9.2**	8.9
Cadmium (refined production)			Japan	United States	China	**Canada**	Belgium
	t	18 923	2 472	2 059	1 600	**1 471**	1 420
	% of world total		13.1	10.9	8.5	**7.8**	7.5
Gold (mine production)			South Africa	United States	Australia	**Canada**	China
	t	2 402	492	357	312	**171**	157
	% of world total		20.5	14.9	13.0	**7.1**	6.5
Salt (mine production)			United States	China	Germany	**Canada**	India
	000 t	201 270	41 400	29 300	15 700	**13 534**	9 500
	% of world total		20.6	14.6	7.8	**6.7**	4.7
Lead (mine production)			China	Australia	United States	Peru	**Canada**
	000 t	3 053	700	531	459	258	**186**
	% of world total		22.9	17.4	15.0	8.5	**6.1**
Molybdenum (Mo content) (mine production)			United States	China	Chile	Russia	**Canada**
	t	141 050	60 900	32 000	17 900	8 500	**8 223**
	% of world total		43.2	22.7	12.7	6.0	**5.8**

Sources: Natural Resources Canada; U.S. Geological Survey.
e Estimated; p Preliminary.
C.I.S.: Commonwealth of Independent States.

TABLE 9. CANADA, GROSS DOMESTIC PRODUCT OF INDUSTRIAL PRODUCTION, MINING AND MINERAL MANUFACTURING AT FACTOR COST AT 1992 PRICES, 1992-98

	1992	1993	1994	1995	1996	1997	1998
				($ millions)			
Total industrial production	141 603	148 010	157 555	164 931	167 140	175 818	180 033
Total mining	23 054	23 942	25 067	26 321	26 837	27 935	27 799
METALS							
Gold mines	1 203	1 162	1 061	1 065	1 150	1 194	1 163
Iron mines	433	421	499	503	481	520	504
Other metal mines	3 358	3 077	2 745	2 846	2 975	2 750	2 821
MINERAL FUELS							
Crude oil and natural gas	14 001	14 708	15 412	16 265	16 530	16 853	17 422
NONMETALS							
Asbestos	110	101	102	n.a.	n.a.	n.a.	n.a.
Potash	706	655	792	845	727	808	805
Salt	147	142	167	142	161	177	173
Coal	797	929	966	1 014	1 048	1 068	1 008
Quarry and sand pits	562	609	679	758	693	713	815
Miscellaneous nonmetals	200	223	264	n.a.	n.a.	n.a.	n.a.
SERVICES RELATED TO MINING	1 537	1 915	2 380	2 506	2 702	3 471	2 722
MINERAL MANUFACTURING							
Primary metals	5293	5617	5646	5817	5977	6180	6214
Primary steel	2 035	2 292	2 347	2 381	2 466	2 551	2 480
Steel pipe and tube mills	333	422	457	426	473	545	538
Iron foundries	478	514	498	592	527	528	492
Nonferrous smelting and refining	1 775	1 633	1 600	1 641	1 699	1 704	1 766
Casting, rolling and extruding	672	756	744	777	812	852	938
Nonmetallic mineral products	2547	2589	2656	2708	2754	2947	3196
Cement	319	339	375	374	377	395	395
Concrete products	408	358	384	428	406	438	480
Ready-mix concrete	407	453	461	424	437	440	476
Glass and glass products	582	609	626	634	664	757	897
Miscellaneous nonmetallic products	831	830	810	848	870	917	948
Petroleum and coal products	975	982	1029	1105	1166	1191	1188

Sources: Natural Resources Canada; Statistics Canada.
n.a. Not applicable.

TABLE 10. CANADA, GROSS DOMESTIC PRODUCT BY INDUSTRY AT FACTOR COST AT 1992 PRICES, 1992-98

	1992	1993	1994	1995	1996	1997	1998
				($ millions)			
Gross domestic product, all industries	604 275	618 422	645 956	662 122	671 391	698 259	717 548
Agriculture	10 260	11 127	11 391	11 340	11 810	11 754	11 880
Fishing and trapping	1 026	1 059	865	692	730	753	693
Logging and forestry	4 031	4 243	4 442	4 766	4 818	4 800	4 673
Mines (including milling), quarries and oil wells	23 054	23 942	25 067	26 321	26 837	27 935	27 799
Manufacturing	96 181	101 101	108 859	114 281	115 658	123 155	128 018
Construction	37 112	35 774	36 880	35 396	36 060	38 270	38 745
Transportation and storage	26 078	27 109	29 380	29 915	30 255	31 834	32 325
Communications	19 541	19 096	19 886	20 362	21 045	22 312	23 964
Electric power, gas and water utilities	22 368	22 967	23 629	24 329	24 645	24 728	24 216
Trade, wholesale	30 892	31 435	34 194	35 202	36 109	39 357	42 219
Trade, retail	35 262	36 537	38 793	40 239	40 556	42 825	44 724
Finance, insurance and real estate	97 577	100 556	105 182	108 258	111 522	115 728	118 641
Community, business and personal services	27 782	29 227	30 874	33 392	35 315	38 050	41 046
Government services	45 409	45 401	45 725	44 941	43 482	42 797	42 706

Source: Statistics Canada.

TABLE 11. CANADA, STAGE I TO STAGE IV, DOMESTIC EXPORTS OF MINERALS AND MINERAL PRODUCTS BY COMMODITY, 1996-98

	Unit of Measure	1996		1997		1998p	
	(000)	(Quantity)	($000)	(Quantity)	($000)	(Quantity)	($000)
METALS							
Aluminum	. .	. .	6 328 775	. .	7 127 264	. .	7 137 180
Antimony	kg	1 434	2 332	244	875	769	1 403
Bismuth	kg	141	1 517	135	1 415	175	2 015
Cadmium	kg	1 722	8 198	2 622	5 612	2 097	3 205
Calcium metal	kg	4 570	3 655	5 685	4 281	5 616	3 661
Chromium	kg	8 749	29 370	7 902	33 642	7 085	31 948
Cobalt	kg	5 120	385 335	6 356	431 471	6 911	463 890
Copper	. .	. .	3 028 916	. .	2 929 108	. .	2 385 148
Gold	. .	. .	3 547 590	. .	3 485 710	. .	3 384 271
Iron and steel	. .	. .	8 238 652	. .	8 495 816	. .	9 606 446
Iron ore	t	27 920	1 032 860	32 340	1 262 406	30 180	1 286 304
Lead	. .	. .	430 810	. .	334 083	. .	284 009
Magnesium and magnesium compounds	kg	101 974	221 788	106 592	252 921	111 542	273 808
Molybdenum	kg	8 771	71 562	11 303	91 702	10 759	67 691
Nickel	. .	. .	2 339 044	. .	2 119 890	. .	1 903 017
Platinum group	. .	. .	158 116	. .	182 857	. .	207 789
Silver	. .	. .	433 218	. .	350 772	. .	507 443
Tin	. .	. .	20 261	. .	17 343	. .	13 793
Uranium and thorium	. .	. .	960 516	. .	970 889	. .	785 718
Zinc	kg	1 331 509	1 486 297	1 121 286	1 789 170	1 054 247	1 526 058
Other metals	. .	. .	3 510 826	. .	4 112 100	. .	4 780 624
Total metals		. .	32 239 638	. .	33 999 327	. .	34 655 421
NONMETALS							
Asbestos	. .	. .	353 188	. .	308 350	. .	264 060
Barite and witherite	t	15	5 285	21	5 907	25	9 158
Diamonds	kg	. .	16 794	. .	13 660	110	6 869
Graphite	. .	. .	132 208	. .	132 581	. .	126 945
Gypsum	. .	. .	230 768	. .	288 927	. .	341 734
Mica	t	17	9 516	16	9 240	18	11 308
Nepheline syenite	t	269	43 919	372	50 498	338	52 205
Peat	. .	. .	289 132	. .	288 094	. .	320 061
Potash and potassium compounds	kg	12 961 046	1 546 155	14 647 353	1 752 693	14 278 275	1 978 593
Salt and sodium compounds	t	4 959	543 287	4 727	503 537	5 227	542 661
Sulphur and sulphur compounds	kg	7 697	495 545	8 185	468 190	6 803	356 041
Talc, soapstone and pyrophyllite	kg	26	7 607	26	8 010	30	10 227
Titanium oxides	kg	69 781	152 332	79 185	172 758	83 861	211 129
Other nonmetals	. .	. .	2 549 744	. .	2 842 054	. .	2 798 073
Total nonmetals		. .	6 375 480	. .	6 844 499	. .	7 029 064
STRUCTURAL MATERIALS							
Cement	. .	. .	506 880	. .	573 844	. .	628 957
Clay and clay products	. .	. .	41 809	. .	44 475	. .	39 427
Lime	kg	216 849	24 701	224 233	27 203	171 447	21 304
Sand and gravel	t	1 428	11 844	1 809	15 680	1 999	19 737
Silica and silica compounds	. .	. .	13 995	. .	18 370	. .	16 426
Stone	. .	. .	104 479	. .	128 992	. .	153 370
Other structural materials	. .	. .	49 807	. .	57 682	. .	96 407
Total structural materials		. .	753 515	. .	866 246	. .	975 628
FUELS							
Coal and coke	t	34 979	2 620 374	36 158	2 734 570	33 258	2 504 909
Natural gas	000 m^3	80 117	7 432 768	81 795	8 625 631	87 326	8 858 923
Natural gas by-products	000 m^3	8	1 154 199	8	1 161 236	9	860 303
Petroleum	. .	. .	17 040 149	. .	17 003 934	. .	12 978 294
Other fuels	kg	193 888	251 406	163 634	257 592	163 696	269 320
Total fuels		. .	28 498 896	. .	29 782 963	. .	25 471 749
Total mineral domestic exports (including fuels)		. .	67 867 529	. .	71 493 035	. .	68 131 862
Total economy domestic exports		. .	259 265 000	. .	281 255 740	. .	296 699 975

Sources: Natural Resources Canada; Statistics Canada.
. . Not available or not applicable; p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 12. CANADA, STAGE I TO STAGE IV, IMPORTS OF MINERALS AND MINERAL PRODUCTS BY COMMODITY, 1996-98

	Unit of Measure	1996		1997		1998p	
	(000)	(Quantity)	($000)	(Quantity)	($000)	(Quantity)	($000)
METALS							
Aluminum	. .	. .	3 373 306	. .	3 827 343	. .	4 359 671
Antimony	kg	2 515	11 917	2 514	11 017	2 670	9 747
Bismuth	kg	98	2 102	237	3 043	220	2 426
Cadmium	kg	736	1 502	487	1 341	35	607
Calcium metal	kg	44 889	35 803	53 902	40 576	74 768	47 542
Chromium	kg	112 877	94 366	104 999	97 948	96 008	93 994
Cobalt	kg	1 123	70 232	1 213	63 955	1 522	62 975
Copper	. .	. .	1 646 903	. .	1 810 201	. .	1 624 140
Gold	. .	. .	1 077 642	. .	1 438 458	. .	1 577 937
Iron and steel	. .	. .	10 245 590	. .	12 912 369	. .	15 379 922
Iron ore	t	6 911	334 255	7 148	357 847	7 255	387 944
Lead	. .	. .	498 422	. .	551 199	. .	589 792
Magnesium and magnesium compounds	kg	390 826	157 023	326 106	203 457	277 286	186 701
Molybdenum	kg	3 686	38 652	3 677	40 489	4 216	41 009
Nickel	. .	. .	757 023	. .	599 185	. .	639 258
Platinum group	g	243 738	207 343	266 556	228 667	195 251	182 448
Silver	. .	. .	125 790	. .	142 383	. .	136 801
Tin	. .	. .	56 634	. .	59 240	. .	61 700
Uranium and thorium	. .	. .	248 005	. .	219 999	. .	223 827
Zinc	. .	. .	153 816	. .	275 855	. .	234 856
Other metals	. .	. .	6 887 494	. .	8 348 454	. .	10 003 004
Total metals			26 025 820		31 233 026		35 846 301
NONMETALS							
Asbestos	. .	. .	75 281	. .	85 281	. .	81 023
Barite and witherite	t	16	1 868	22	2 994	14	2 479
Diamonds	. .	. .	191 132	. .	223 942	. .	251 119
Graphite	. .	. .	335 829	. .	369 379	. .	447 787
Gypsum	. .	. .	24 787	. .	30 779	. .	36 164
Mica	t	4	10 460	4	12 369	5	11 469
Nepheline syenite	. .	. . .	52	. . .	12	. . .	3
Peat	. .	. .	750	. .	1 289	. .	2 743
Potash and potassium compounds	kg	. .	35 430	. .	39 055	118 389	41 588
Salt and sodium compounds	t	2 155	325 159	2 306	318 140	1 930	308 783
Sulphur and sulphur compounds	kg	110	15 975	152	19 096	189	21 688
Talc, soapstone and pyrophyllite	kg	58	15 283	56	13 072	47	12 173
Titanium oxides	kg	84 713	180 046	111 291	231 247	117 814	272 653
Other nonmetals	. .	. .	3 122 830	. .	3 480 783	. .	3 959 731
Total nonmetals			4 334 882		4 827 438		5 449 403
STRUCTURAL MATERIALS							
Cement	. .	. .	157 885	. .	188 201	. .	210 343
Clay and clay products	. .	. .	671 334	. .	762 951	. .	862 270
Lime	kg	36 640	5 054	47 382	6 380	33 988	5 752
Sand and gravel	t	3 241	16 300	3 207	17 619	3 068	18 955
Silica and silica compounds	. .	. .	109 098	. .	125 737	. .	143 146
Stone	. .	. .	93 950	. .	105 411	. .	134 142
Other structural materials	. .	4	57 623	4	67 242	. .	78 031
Total structural materials			1 111 244		1 273 541		1 452 639
FUELS							
Coal and coke	t	12 860	757 557	15 939	879 158	20 880	1 141 455
Natural gas	000 m³	1 923	111 361	953	137 292	734	103 999
Natural gas by-products	000 m³	. . .	70 227	. . .	56 091	. . .	56 626
Petroleum	. .	. .	9 592 959	. .	11 428 616	. .	9 143 758
Other fuels	. .	. .	306 498	. .	347 478	. .	449 774
Total fuels			10 838 602		12 848 635		10 895 612
Total mineral imports (including fuels)			42 310 548		50 182 640		53 643 955
Total economy imports			232 648 033		272 855 758		298 316 804

Sources: Natural Resources Canada; Statistics Canada.
. . Not available or not applicable; . . . Amount too small to be expressed; p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 13. CANADA, STAGE I TO STAGE IV, VALUE OF MINERALS AND MINERAL PRODUCTS, EXPORTS BY COMMODITY, BY DESTINATION, 1998p

	United States	EU	Japan	Mexico	Other	Total
			($000)			
METALS						
Aluminum	6 078 786	516 915	342 885	6 864	191 730	7 137 180
Antimony	870	508	–	–	25	1 403
Bismuth	1 810	205	–	–	–	2 015
Cadmium	1 402	1 059	683	–	61	3 205
Calcium metal	1 602	1 667	104	–	288	3 661
Chromium	31 381	568	–	–	. . .	31 948
Cobalt	77 143	120 821	67 337	9	198 580	463 890
Copper	1 750 675	190 662	204 471	10 250	229 090	2 385 148
Gold	2 782 025	33 104	53 278	–	515 864	3 384 271
Iron and steel	9 088 890	145 805	35 172	44 084	292 495	9 606 446
Iron ore	426 269	686 264	22 710	–	151 061	1 286 304
Lead	218 172	43 098	778	603	21 358	284 009
Magnesium and magnesium compounds	207 871	36 597	12 204	–	17 136	273 808
Molybdenum	5 393	17 479	35 384	–	9 435	67 691
Nickel	548 041	592 004	64 630	5 398	692 944	1 903 017
Platinum group	90 793	115 731	1 111	–	154	207 789
Silver	416 090	58 876	30 104	26	2 347	507 443
Tin	13 099	272	90	–	332	13 793
Uranium and thorium	573 030	57 517	22 242	460	132 469	785 718
Zinc	995 528	336 299	52 557	19	141 655	1 526 058
Other metals	4 057 781	316 218	148 054	11 849	246 722	4 780 624
Total metals	27 366 651	3 271 669	1 093 794	79 562	2 843 746	34 655 421
NONMETALS						
Asbestos	66 673	13 470	38 340	13 026	132 551	264 060
Barite and witherite	8 906	–	–	–	252	9 158
Diamonds	5 779	632	23	–	435	6 869
Graphite	105 868	8 337	66	–	12 674	126 945
Gypsum	338 935	974	60	–	1 765	341 734
Mica	9 294	475	1 229	–	310	11 308
Nepheline syenite	46 753	1 339	672	100	3 341	52 205
Peat	273 375	19 898	15 087	–	11 701	320 061
Potash and potassium compounds	1 133 663	50 874	69 604	2 143	722 309	1 978 593
Salt and sodium compounds	494 926	1 133	9 048	185	37 369	542 661
Sulphur and sulphur compounds	130 438	8	–	17 667	207 928	356 041
Talc, soapstone and pyrophyllite	10 227	–	–	–	–	10 227
Titanium oxides	191 779	13 868	–	–	5 482	211 129
Other nonmetals	2 609 706	81 877	18 943	320	87 227	2 798 073
Total nonmetals	5 426 322	192 885	153 072	33 441	1 223 344	7 029 064
STRUCTURAL MATERIALS						
Cement	620 827	2 520	2 738	–	2 872	628 957
Clay and clay products	32 564	2 797	332	15	3 719	39 427
Lime	21 288	10	–	–	6	21 304
Sand and gravel	17 791	25	–	–	1 921	19 737
Silica and silica compounds	15 526	158	–	47	695	16 426
Stone	138 156	4 581	5 096	–	5 537	153 370
Other structural materials	91 315	529	528	293	3 742	96 407
Total structural materials	937 467	10 620	8 694	355	18 492	975 628
FUELS						
Coal and coke	205 463	387 126	1 193 975	15 157	703 188	2 504 909
Natural gas	8 858 923	–	–	–	–	8 858 923
Natural gas by-products	860 265	16	–	–	22	860 303
Petroleum	12 597 143	86 375	10 457	132	284 187	12 978 294
Other fuels	232 819	11 005	3 130	214	22 152	269 320
Total fuels	22 754 613	484 522	1 207 562	15 503	1 009 549	25 471 749
Total domestic mineral exports	56 485 053	3 959 696	2 463 122	128 861	5 095 131	68 131 862

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . . Amount too small to be expressed; p Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 14. CANADA, STAGE I TO STAGE IV, VALUE OF MINERALS AND MINERAL PRODUCTS, IMPORTS BY COMMODITY, BY ORIGIN, 1998P

	United States	EU	Japan	Mexico	Other	Total
			($000)			
METALS						
Aluminum	3 223 441	219 960	10 037	2 932	903 301	4 359 671
Antimony	6 336	2 555	–	–	856	9 747
Bismuth	1 860	90	–	–	476	2 426
Cadmium	270	337	–	–	–	607
Calcium metal	36 271	5 485	17	. . .	5 769	47 542
Chromium	31 018	6 398	1 898	2 469	52 211	93 994
Cobalt	17 799	4 724	793	–	39 659	62 975
Copper	1 182 746	115 528	10 884	9 263	305 719	1 624 140
Gold	1 118 035	56 180	305	82	403 335	1 577 937
Iron and steel	10 762 881	1 528 013	850 963	272 408	1 965 657	15 379 922
Iron ore	358 824	101	3	2 536	26 480	387 944
Lead	473 652	23 851	13 525	17 329	61 435	589 792
Magnesium and magnesium compounds	102 512	13 969	884	1 412	67 924	186 701
Molybdenum	27 582	3 532	9	2 436	7 450	41 009
Nickel	207 750	58 889	76 780	19 401	276 438	639 258
Platinum group	66 564	30 662	9	518	84 695	182 448
Silver	65 978	12 497	737	3 151	54 438	136 801
Tin	33 345	2 942	21	265	25 127	61 700
Uranium and thorium	48 243	13 779	88	–	161 717	223 827
Zinc	179 008	7 324	182	13 071	35 271	234 856
Other metals	6 608 867	873 214	271 502	930 899	1 318 522	10 003 004
Total metals	24 552 982	2 980 030	1 238 637	1 278 172	5 796 480	35 846 301
NONMETALS						
Asbestos	69 840	1 695	3 629	1 283	4 576	81 023
Barite and witherite	2 123	256	–	–	100	2 479
Diamonds	41 507	76 744	134	. . .	132 734	251 119
Graphite	342 585	47 992	16 053	3 475	37 682	447 787
Gypsum	31 518	1 064	47	2 520	1 015	36 164
Mica	8 667	1 800	279	15	708	11 469
Nepheline syenite	2	–	–	–	1	3
Peat	923	990	–	–	830	2 743
Potash and potassium compounds	34 742	2 444	53	15	4 334	41 588
Salt and sodium compounds	267 199	24 497	526	5 352	11 209	308 783
Sulphur and sulphur compounds	20 749	818	8	–	113	21 688
Talc, soapstone and pyrophyllite	11 803	161	100	–	109	12 173
Titanium oxides	163 594	87 689	1 254	. . .	20 116	272 653
Other nonmetals	3 064 493	374 569	76 388	92 197	352 084	3 959 731
Total nonmetals	4 059 745	620 719	98 471	104 857	565 611	5 449 403
STRUCTURAL MATERIALS						
Cement	183 260	9 169	707	4 655	12 552	210 343
Clay and clay products	367 026	219 586	31 955	39 341	204 362	862 270
Lime	5 700	51	–	–	1	5 752
Sand and gravel	18 651	110	. . .	13	181	18 955
Silica and silica compounds	124 178	14 134	2 328	97	2 409	143 146
Stone	57 464	44 339	13	1 702	30 624	134 142
Other structural materials	62 432	8 384	247	1 527	5 441	78 031
Total structural materials	818 711	295 773	35 250	47 335	255 570	1 452 639
FUELS						
Coal and coke	1 077 901	14 371	4 567	37	44 579	1 141 455
Natural gas	103 992	1	1	–	5	103 999
Natural gas by-products	56 120	78	26	. . .	402	56 626
Petroleum	2 919 707	1 160 560	12 639	206 720	4 844 132	9 143 758
Other fuels	386 123	56 529	2 771	1 444	2 907	449 774
Total fuels	4 543 843	1 231 539	20 004	208 201	4 892 025	10 895 612
Total mineral imports	33 975 281	5 128 061	1 392 363	1 638 566	11 509 686	53 643 955

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . . Amount too small to be expressed; P Preliminary.
Note: Numbers may not add to totals due to rounding.

TABLE 15. CANADA, APPARENT CONSUMPTION[1] OF SOME MINERALS AND RELATION TO PRODUCTION,[2] 1995-97

	1995			1996			1997		
	Apparent Consumption	Production	Consumption as a Percentage of Production	Apparent Consumption	Production	Consumption as a Percentage of Production	Apparent Consumption	Production	Consumption as a Percentage of Production
	(tonnes)		(%)	(tonnes)		(%)	(tonnes)		(%)
Quartz silica	3 013 201	1 872 731	160.9	1 925 575r	1 668 462r	115.4	1 812 229	1 792 778	101.1
Lime[3]	2 248 125	2 461 716	91.3	2 221 823	2 402 032	92.5	2 299 721	2 476 571	92.9
Salt	9 265 578r	10 957 384	84.6	9 569 294r	12 248 477	78.1	11 125 670	13 496 856	82.4
Cement[4]	6 183 562	10 440 329	59.2	6 864 706	11 587 365	59.2	7 155 518	11 736 272	61.0
Iron ore	13 890 447	36 627 937	37.9	13 353 341	34 399 968	38.8	13 695 398	38 927 855	35.2
Gypsum	2 666 640	8 054 741	33.1	2 922 971	8 201 774	35.6	2 866 713	8 627 772	33.2
Potash (K_2O equivalent)	452 561	8 854 690	5.1	257 042	8 120 389	3.2	374 711	9 234 742	4.1
Asbestos	6 275	515 553	1.2	2 622	506 276	0.5	–	420 278	. .

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; K_2O potassium oxide; r Revised.
1 "Apparent consumption" is production plus imports, less exports. 2 "Production" refers to producers' shipments. 3 Apparent consumption contains slaked lime in the trade data. 4 Apparent consumption contains clinker cement in the trade data.

TABLE 16. CANADA, REPORTED CONSUMPTION OF MINERALS AND RELATION TO PRODUCTION, 1995-97

		1995			1996			1997		
	Unit of Measure	Consumption	Production	Consumption as a Percentage of Production	Consumption	Production	Consumption as a Percentage of Production	Consumption	Production	Consumption as a Percentage of Production
				(%)			(%)			(%)
METALS										
Aluminum[1]	t	635 402	2 171 992	29.3	686 969	2 283 212	30.1	781 268	2 327 188	33.6
Antimony	kg	988 338	574 448	172.1	688 800	1 380 169	49.9	1 158 210	529 109	218.9
Bismuth	kg	205 813	158 641	129.7	116 111	149 839	77.5	65 378	195 720	33.4
Cadmium	kg	93 440	1 688 439	5.5	99 323	1 540 072	6.4	123 192	1 272 172	9.7
Chromium (chromite)	t	21 951	–	. .	17 466	–	. .	15 380	–	. .
Cobalt	kg	148 331	2 018 484	7.4	147 350	2 150 339	6.9	136 382	2 167 554	6.3
Copper[2]	t	189 550r	700 843	27.0r	218 280	652 499	33.5	224 777	647 779	34.7
Lead[3]	t	91 171	204 227	44.6	93 373	241 751	38.6	92 999	170 847	54.4
Magnesium	t	27 140	x	x	27 576	x	x	34 026	x	x
Manganese ore	t	9 061	–	. .	9 747	–	. .	9 668	–	. .
Mercury	kg	2 985	–	. .	6 327	–	. .	x	–	x
Molybdenum (Mo content)	t	2 066r	9 113	22.7r	2 305r	8 789	26.2r	2 545	7 594	33.5
Nickel	t	20 973	172 107	12.2	24 504	182 404	13.4	19 447	180 624	10.8
Selenium	kg	15 046	561 307	2.7	15 815	693 668	2.3	9 175	592 135	1.5
Silver	kg	432 015r	1 244 606	34.7r	410 730r	1 242 846	33.0r	333 402	1 193 970	27.9
Tellurium	kg	x	102 268	x	x	58 700	x	x	59 322	x
Tin	t	3 044	–	. .	2 796	–	. .	2 850	–	. .
Tungsten (W content)	kg	376 840	–	. .	397 770	–	. .	289 934	–	. .
Zinc[3]	t	132 915r	1 094 703	12.1r	136 967r	1 162 720	11.8	135 730	1 026 864	13.2
NONMETALS										
Barite	t	17 118	60 662	28.2	14 399	57 967	24.8	11 765	84 091	14.0
Feldspar	t	1 492	–	. .	1 504	–	. .	1 578	–	. .
Fluorspar	t	16 570	–	. .	23 814	–	. .	75 791	–	. .
Mica	t	2 828	x	x	3 211	x	x	3 334	x	x
Nepheline syenite	t	68 704	616 693	11.1	76 577	608 439	12.6	73 264	648 280	11.3
Phosphate rock	t	1 202 533	–	. .	x	–	. .	x	–	. .
Potash (K_2O equivalent)	t	210 332	8 854 690	2.4	216 349	8 120 389	2.7	217 841	9 234 742	2.4
Sodium sulphate	t	121 717	314 770	38.7	113 985	323 326	35.3	112 906	285 198	39.6
Sulphur	t	905 021	8 732 737	10.4	757 705	9116 366	8.3	758 886	9 072 374	8.4
Talc, etc.	t	96 677	106 327	91.3	91 498	77 016	118.8	84 991	72 444	117.3
MINERAL FUELS										
Coal	000 t	52 771	74 920	70.4	53 509	75 860	70.5	55 098	78 670	70.0
Crude oil[4]	000 m^3	87 663	114 372	76.6	92 687	117 621	78.8	96 431	123 827	77.9
Natural gas[5]	million m^3	52 078	148 203	35.1	54 674	153 578	35.6	52 541	156 171	33.6

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available; r Revised; x Confidential.
1 Consumption of primary aluminum ingot and alloys, and secondary ingot and scrap, reported by consumers. 2 Consumption is efined as domestic shipments of refined copper plus imports of refined copper. 3 Consumption of primary and secondary refined metal. 4 Consumption is defined as refinery receipts. 5 Consumption is defined as domestic sales.
Notes: Unless otherwise stated, consumption refers to reported consumption of refined metals or nonmetallic minerals by consumers. Production of metals, in most cases, refers to production in all forms, and includes the recoverable content of ores, concentrates, matte, etc., and the metal content of primary products recoverable at domestic smelters and refineries. Production of nonmetals refers to producers' shipments. For fuels, production is equivalent to actual output less waste.

TABLE 17. CANADA, DOMESTIC CONSUMPTION OF PRINCIPAL REFINED METALS IN RELATION TO REFINERY PRODUCTION,[1] 1991-97

	Unit of Measure	1991	1992	1993	1994	1995	1996	1997
ALUMINUM								
Domestic consumption[2]	t	446 239	481 089	568 854	635 024	635 402	686 969	781 268
Production	t	1 821 642	1 971 843	2 308 867	2 254 683	2 171 992	2 283 212	2 327 188
Consumption as a percentage of production	%	24.5	24.4	24.6	28.2	29.3	30.1	33.6
COPPER								
Domestic consumption[3]	t	159 170	156 132	185 565	199 350	189 550[r]	218 280	224 777
Production	t	538 339	539 302	561 580	549 869	572 616	560 582	560 582
Consumption as a percentage of production	%	29.6	29.0	33.0	36.3	33.1	38.9	40.1
LEAD								
Domestic consumption[4]	t	80 253	92 420	91 915	95 764	91 171	93 373	92 999
Production[5]	t	212 366	252 885	217 014	251 640	281 391	310 791	271 395
Consumption as a percentage of production	%	37.8	36.5	42.4	38.1	32.4	30.0	34.3
ZINC								
Domestic consumption[4]	t	104 902	114 725	111 876[r]	124 296[r]	132 915[r]	136 967[r]	135 730
Production	t	660 552	671 702	659 881	690 965	720 346	716 467	703 798
Consumption as a percentage of production	%	15.9	17.1	17.0	18.0[r]	18.5	19.1[r]	19.3

Source: Natural Resources Canada.
[r] Revised.
[1] Production of refined metal from all sources, including metal derived from secondary materials at primary refineries. [2] Consumption of primary aluminum ingot and alloys, and secondary ingot and scrap, reported by consumers. [3] Consumption is defined as domestic shipments of refined copper plus imports of refined copper. [4] Consumption of primary and secondary refined metal, reported by consumers. [5] Production of primary and secondary refined lead.

TABLE 18. AVERAGE ANNUAL PRICES[1] OF SELECTED METALS, 1991-98

	Unit	1991	1992	1993	1994	1995	1996	1997	1998
Aluminum, London Metal Exchange	¢/lb	59.066	56.893	51.639	66.986	81.903	68.296	72.544	61.574
Antimony, New York dealer	$/lb	0.826	0.791	0.769	1.777	2.278	1.466	0.996	0.718
Bismuth, New York dealer	$/lb	2.969	2.506	2.350	3.070	3.781	3.546	3.275	3.408
Cadmium, New York dealer	$/lb	1.974	0.907	0.451	1.144	1.839	1.238	0.513	0.286
Cobalt, metal, shot/cathode/250 kg	$/lb	11.000	24.300	18.000	19.900	27.069	27.500	27.500	27.500
Copper, electrolytic cathode, COMEX	¢/lb	108.211	102.721	85.283	107.052	134.717	105.872	103.580	75.077
Gold, London[2]	$/troy oz	362.183	343.731	359.769	384.009	384.162	387.696	331.096	294.160
Indium, New York dealer	$/troy oz	281.354	155.167	45.667	30.000	30.000	48.188	171.125	392.032
Lead, London Metal Exchange cash	¢/lb	25.269	24.534	18.417	24.829	28.600[r]	35.019	28.292	23.960
Magnesium, U.S. primary ingot (Producer Price List)	$/lb	1.430	1.438	1.530	1.538	1.805	1.930	1.800	1.800
Manganese, U.S. metal, regular	¢/lb	104.000	104.000	104.000	104.000	109.250	115.000	115.000	105.417
Molybdenum, dealer, oxide	$/lb	2.349	2.197	2.279	4.501	7.412	3.606	4.175	3.313
Nickel, New York dealer, cathode	$/lb	3.796	3.177	2.428	2.919	3.901	3.501	3.221	2.179
Osmium, New York dealer	$/troy oz	400.000	400.000	400.000	400.000	399.375	392.458	391.000	366.667
Palladium, London PM fix	$/troy oz	88.290	88.228	122.348	142.631	151.229	128.079	177.951	284.678
Platinum, London PM fix	$/troy oz	376.083	359.799	374.027	404.998	424.348	397.171	395.210	372.019
Rhodium, New York dealer	$/troy oz	3 739.126	2 365.102	1 066.111	712.678	424.145	280.721	268.458	574.771
Ruthenium, New York dealer	$/troy oz	55.233	26.538	12.996	13.604	21.827	34.921	32.896	39.208
Selenium, New York dealer	$/lb	5.241	4.947	4.900	4.900	4.897	3.423	2.791	2.274
Silver, Handy & Harman, Toronto	$/troy oz	4.039	3.936	4.300	5.284	5.192	5.163	4.892	5.534
Tantalum, tantalite ore, spot	$/lb	28.536	27.365	25.850	25.500	26.260	27.000	27.000	32.783
Tin, New York dealer	$/lb	2.588	2.822	2.392	2.549	2.945	2.890	2.644	2.613
Tungsten, U.S. spot ore	$/stu	53.417	49.325	34.800	36.750	56.402	55.000	53.333	48.525
Uranium, U_3O_8	$/lb	21.000	19.000	15.000	14.000	13.000	15.100[r]	14.200	13.300
Zinc, special high grade	¢/lb	50.647	56.235	43.635	45.255	53.235	51.109	59.697	46.453

Sources: Natural Resources Canada; *Metals Week*.
COMEX: Commodities Exchange, Inc.
[r] Revised; stu short ton unit.
[1] Prices, except where noted, are in U.S. currency. [2] Average afternoon fixings of London bullion dealers.

TABLE 19. CANADIAN AVERAGE ANNUAL PRICES OF SELECTED METALS, 1991-98

	Unit	1991	1992	1993	1994	1995	1996	1997	1998
Aluminum, London Metal Exchange	$/kg	1.492	1.516	1.469	2.017	2.478	2.054	2.215	1.952
Antimony, New York dealer	$/kg	2.092	2.107	2.187	5.350	6.893	4.408	3.042	2.276
Bismuth, New York dealer	$/kg	7.500	6.676	6.684	9.243	11.441	10.663	10.000	10.805
Cadmium, New York dealer	$/kg	4.986	2.416	1.283	3.444	5.565	3.723	1.566	0.907
Cobalt, metal, shot/cathode/250 kg	$/kg	27.787	64.731	51.195	59.916	81.906	82.695	83.968	87.188
Copper, electrolytic cathode, COMEX	$/kg	2.733	2.736	2.426	3.223	4.076	3.184	3.163	2.380
Gold, London[1]	$/g	13.342	13.353	14.922	16.861	16.952	17.002	14.743	13.601
Iridium, New York dealer	$/g	10.365	6.028	1.894	1.317	1.324	2.026	7.620	18.126
Lead, London Metal Exchange, cash	¢/kg	55.709	54.088	40.602	54.739	63.052	77.204	62.373	52.823
Magnesium, U.S. primary ingot									
(Producer Price List)	$/kg	3.612	3.631	4.352	4.631	5.462	5.804	5.496	5.707
Manganese, U.S. metal, regular	$/kg	2.627	2.770	2.958	3.131	3.306	3.458	3.511	3.342
Molybdenum, dealer, oxide	$/kg	5.934	5.852	6.482	13.552	22.428	10.844	12.748	10.504
Nickel, New York dealer, cathode	$/kg	9.589	8.463	6.906	8.789	11.804	10.528	9.835	6.908
Osmium, New York dealer	$/g	14.735	15.539	16.591	17.563	17.623	17.211	17.411	16.962
Palladium, London PM fix	$/g	3.252	3.427	5.075	6.263	6.673	5.617	7.924	13.162
Platinum, London PM fix	$/g	13.854	13.977	15.514	17.783	18.725	17.417	17.598	17.201
Rhodium, New York dealer	$/g	137.743	91.679	44.220	31.292	18.716	12.311	11.054	26.575
Ruthenium, New York dealer	$/g	2.035	1.109	0.539	0.597	0.963	1.531	1.465	1.813
Selenium, New York dealer	$/kg	13.239	13.178	13.936	14.753	14.818	10.293	8.522	7.210
Silver, Handy & Harman, Toronto	$/kg	148.790	152.905	178.354	232.011	229.107	227.293	217.835	255.870
Tantalum, tantalite ore, spot	$/kg	72.089	72.896	73.522	76.777	79.459	81.192	82.442	103.937
Tin, New York dealer	$/kg	6.537	7.517	6.803	7.675	8.911	8.690	8.075	8.284
Tungsten, U.S. spot ore	$/mtu	60.239	58.658	44.186	49.397	76.189	73.835	72.700	68.681
Uranium	$/kg	61.000	59.000	50.000	51.000	47.000	53.600r	51.300	51.100
Zinc, special high grade	$/kg	1.279	1.498	1.241	1.363	1.611	1.537	1.823	1.473

Sources: Natural Resources Canada; *Metals Week.*
COMEX: Commodities Exchange, Inc.
mtu metric tonne unit; r Revised.
[1] Average afternoon fixings of London bullion dealers.

TABLE 20. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY,[1] 1996

		Mining Activity							Total Activity[2]		
		Production and Related Workers			Costs						
	Establish-ments	Employees	Person-Hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Production	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
METALS											
Gold	55	7 595	16 846	457 762	171 609	683 757	2 705 706	1 850 341	10 099	600 824	1 843 392
Silver-lead-zinc	6	2 129	4 751	120 683	60 476	674 794	1 237 809	502 539	3 061	181 758	500 667
Uranium	4	1 031	2 067	53 809	47 118	119 440	636 276	469 718	1 299	72 604	469 672
Iron	5	3 511	7 692	265 421	176 945	446 318	1 458 768	835 505	4 736	356 541	836 170
Nickel-copper-zinc	21	10 923	23 379	601 823	211 204	1 934 936	5 063 000	2 916 860	14 074	822 995	2 946 128
Miscellaneous metal mines[3]	6	641	1 349	33 706	18 730	56 486	213 632	138 415	988	52 707	143 297
Total	97	25 830	56 083	1 533 204	686 082	3 915 731	11 315 190	6 713 377	34 257	2 087 429	6 739 326
INDUSTRIAL MINERALS											
Asbestos	2	x	x	x	x	x	x	x	x	x	x
Peat	70	1 188	2 628	29 921	7 785	36 001	173 304	129 519	1 485	39 045	130 474
Gypsum	9	590	1 259	21 785	7 191	19 386	88 547	61 970	691	27 128	61 884
Potash	11	2 551	5 732	149 498	124 232	162 088	1 304 482	1 018 163	3 506	212 052	1 017 696
Stone	154	2 196	4 935	84 121	43 782	113 506	486 360	329 072	2 914	114 803	335 940
Sand and gravel	322	2 760	6 358	100 144	50 263	99 243	502 439	352 932	3 587	131 804	365 848
Miscellaneous nonmetals[4]	28	1 468	3 304	68 200	29 576	69 307	488 016	389 133	2 021	96 308	389 806
Total	596	12 188	27 369	515 292	289 094	546 660	3 304 520	2 468 565	16 121	707 118	2 490 713
MINERAL FUELS											
Coal	34	7 458	16 071	418 016	151 580	476 461	1 950 089	1 322 046	9 177	511 824	1 349 340
Total mineral industry	727	45 476	99 523	2 466 512	1 126 756	4 939 053	16 569 800	10 503 991	59 555	3 306 371	10 579 379

Sources: Natural Resources Canada; Statistics Canada.
x Confidential.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. [2] Total activity includes sales and head offices.
[3] Includes molybdenum. [4] Includes salt.
Notes: This table no longer includes data for the petroleum and natural gas industries. Numbers may not add to totals due to rounding.

TABLE 21. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY[1] BY REGION, 1996

Region	Establish-ments	Mines, Quarries and Oil Wells Activity: Production and Related Workers: Employees	Person-Hours Paid	Wages	Costs: Fuel and Electricity	Materials and Supplies	Value of Production	Value Added	Total Activity[2]: Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Atlantic provinces[3]	85	6 408	13 677	324 961	143 149	640 068	1 934 598	1 151 383	8 047	412 035	1 145 620
Quebec	217	8 864	19 580	468 771	233 950	922 218	2 790 605	1 634 437	12 547	682 940	1 682 379
Ontario	208	11 975	28 468	635 113	228 194	1 321 795	4 918 263	3 370 274	15 408	833 684	3 366 158
Prairie provinces	144	9 771	21 146	515 579	260 442	818 832	3 541 938	2 462 664	12 403	691 150	2 492 058
British Columbia[4]	63	6 949	14 901	408 137	195 908	877 289	2 548 954	1 475 756	8 779	516 488	1 488 169
Yukon and Northwest Territories[5]	10	1 509	3 751	113 950	67 112	358 853	835 441	409 477	2 372	170 073	404 997
Total Canada	727	45 476	99 523	2 466 511	1 126 755	4 939 053	16 569 799	10 503 991	59 555	3 306 370	10 579 379

Sources: Natural Resources Canada; Statistics Canada.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. [2] Total activity includes sales and head offices. [3] Includes eastern Canada offshore. [4] Includes western Canada offshore. [5] Includes Arctic Islands.
Notes: This table no longer includes data for the petroleum and natural gas industries. Numbers may not add to totals due to rounding.

TABLE 22. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY,[1] 1982-96

Year	Establish-ments	Mines, Quarries and Oil Wells Activity: Production and Related Workers: Employees	Person-Hours Paid	Wages	Costs: Fuel and Electricity	Materials and Supplies	Value of Production	Value Added	Total Activity[2]: Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
1982	490	66 610	125 432	1 765 743	803 031	3 250 826	9 580 998	5 527 141	91 787	2 598 170	5 527 700
1983	481	58 469	114 700	1 684 907	826 427	3 158 440	9 841 152	5 856 285	80 413	2 446 855	5 840 910
1984	472	61 150	123 628	1 987 010	971 932	3 569 181	12 053 167	7 512 054	81 846	2 767 611	7 537 288
1985	472	58 347	121 709	2 009 484	1 005 557	3 605 813	11 664 215	7 052 845	77 663	2 771 242	7 066 445
1986	505	55 542	117 173	2 004 975	951 854	3 655 623	11 734 946	7 127 469	74 497	2 784 083	7 172 484
1987	538	55 776	120 946	2 079 717	938 764	3 896 427	13 729 648	8 894 456	73 821	2 850 388	8 960 120
1988	539	58 251	126 216	2 348 492	970 964	4 463 879	17 060 361	11 625 518	76 995	3 197 609	11 694 930
1989	537	59 593	129 946	2 562 805	1 013 010	4 712 423	17 445 454	11 720 021	78 279	3 460 651	11 826 346
1990	521	55 558	121 448	2 510 617	1 061 769	4 619 245	16 158 688	10 477 673	73 156	3 391 151	10 571 448
1991	498	51 642	112 344	2 446 055	1 043 554	4 318 454	14 359 030	8 997 022	68 747	3 363 119	9 094 572
1992	469	46 819	101 065	2 278 504	960 413	4 249 868	13 705 148	8 494 868	62 257	3 136 794	8 566 223
1993	459	44 053	94 733	2 139 903	933 552	3 931 954	12 598 992	7 733 486	58 325	2 928 793	7 793 020
1994	555	44 208	96 300	2 228 567	970 304	3 938 223	13 872 653	8 964 126	58 320	3 020 618	9 059 983
1995	730	46 718	101 989	2 420 776	1 059 773	4 741 868	16 770 592	10 968 951	61 140	3 259 174	11 048 501
1996	727	45 476	99 523	2 466 511	1 126 755	4 939 053	16 569 799	10 503 991	59 555	3 306 370	10 579 379

Source: Natural Resources Canada.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clay) are included in the mineral manufacturing industry. [2] Total activity includes sales and head offices.
Note: This table no longer includes data for the petroleum and natural gas industries.

TABLE 23. CANADA, CONSUMPTION OF FUEL AND ELECTRICITY IN THE MINERAL INDUSTRY,[1] 1996

	Unit	Metals	Nonmetals	Structural Materials	Total
Coal	000 t	1	–	–	1
	$000	40	–	–	40
Gasoline	000 litres	18 097	3 663	13 569	35 329
	$000	8 613	1 786	6 783	17 182
Fuel oil, kerosene, diesel oil	000 litres	759 336	129 607	130 087	1 019 030
	$000	198 185	34 786	53 671	286 642
Liquefied petroleum gas	000 litres	155 058	12 607	5 674	173 339
	$000	32 292	2 612	1 000	35 904
Natural gas	000 m³	119 150	734 835	22 796	876 781
	$000	12 997	47 550	3 056	63 603
Other fuels[2]	$000	37 596	440	262	38 298
Total value of fuels	$000	289 723	87 173	64 772	441 668
Electricity purchased	million kWh	11 248	2 333	435	14 016
	$000	396 358	107 876	29 273	533 507
Total value of fuels and electricity purchased, all reporting companies	$000	686 082	195 049	94 045	975 176

Sources: Natural Resources Canada; Statistics Canada.
– Nil.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. [2] Includes wood, manufactured gas, steam purchased, and other miscellaneous fuels.
Note: Numbers may not add to totals due to rounding.

TABLE 24. CANADA, COST OF FUEL AND ELECTRICITY USED IN THE NON-FUEL MINERAL INDUSTRY,[1] 1992-96

	Unit	1992	1993	1994	1995	1996
METALS						
Fuel	$000	212 634	194 325	207 602	237 376	289 723
Electricity purchased	million kWh	11 347	10 743	10 705	11 527	11 248
	$000	399 545	379 974	368 124	408 270	396 358
Total cost of fuel and electricity	$000	612 179	574 299	575 726	645 646	686 082
NONMETALS						
Fuel	$000	77 712	80 224	96 445	91 148	87 173
Electricity purchased	million kWh	2 138	2 102	2 301	2 363	2 333
	$000	96 564	98 528	108 050	109 676	107 876
Total cost of fuel and electricity	$000	174 276	178 752	204 496	200 824	195 049
STRUCTURAL MATERIALS						
Fuel	$000	34 380	33 610	42 830	58 609	64 772
Electricity purchased	million kWh	347	357	361	380	435
	$000	21 440	23 082	24 077	25 273	29 273
Total cost of fuel and electricity	$000	55 820	56 692	66 907	83 882	94 045
TOTAL NON-FUEL MINERAL INDUSTRY						
Fuel	$000	324 726	308 159	346 877	387 133	441 668
Electricity purchased	million kWh	13 832	13 202	13 367	14 270	14 016
	$000	517 549	501 584	500 252	543 219	533 507
Total cost of fuel and electricity	$000	842 275	809 743	847 129	930 353	975 176

Sources: Natural Resources Canada; Statistics Canada.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry.
Note: Numbers may not add to totals due to rounding.

TABLE 25. CANADA, EMPLOYMENT IN THE MINERAL INDUSTRY, STAGE I – MINERAL EXTRACTION AND CONCENTRATING (TOTAL ACTIVITY),[1] 1961-98

Year	Metal Mines	Nonmetal Mines	Structural Materials	Non-Fuel Minerals	Coal	Crude Oil and Natural Gas	Total Non-Fuel and Fuel Mineral Industries
SIC no.	061	062	081, 082	061, 062 081, 082	063	071	
				(number)			
1961	58 591	11 003	5 235	74 829	10 302	11 184	96 315
1962	58 243	11 408	5 514	75 165	9 897	11 232	96 294
1963	57 119	11 661	5 686	74 466	9 828	11 237	95 531
1964	57 648	11 727	6 044	75 419	9 796	11 242	96 457
1965	60 942	12 116	6 248	79 306	9 697	11 817	100 820
1966	61 670	12 422	6 312	80 404	9 281	12 378	102 063
1967	61 728	13 077	5 779	80 584	8 981	13 113	102 678
1968	63 369	13 673	5 836	82 878	8 427	13 611	104 916
1969	60 550	14 322	5 692	80 564	7 371	14 153	102 088
1970	66 590	15 150	5 510	87 250	7 874	14 970	110 094
1971	66 012	15 105	5 328	86 445	8 069	15 896	110 410
1972	61 994	14 866	5 154	82 014	8 704	16 604	107 322
1973	66 134	15 391	5 276	86 801	7 856	16 786	111 443
1974	70 038	16 198	6 197	92 433	8 142	18 155	118 730
1975	69 161	13 703	6 382	89 246	8 416	18 053	115 715
1976	68 269	15 649	5 685	89 603	8 995	19 096	117 694
1977	67 242	16 608	5 190	89 040	9 781	20 240	119 061
1978	56 447	16 035	4 847	77 329	10 574	22 045	109 948
1979	58 960	16 770	4 692	80 422	10 269	24 554	115 245
1980	66 118	16 979	4 461	87 558	11 416	27 448	126 422
1981	68 712	16 391	4 183	89 286	11 182	28 783	129 251
1982	61 503	13 680	3 491	78 674	13 113	31 699	123 486
1983	52 194	13 170	3 403	68 767	11 646	33 418	113 831
1984	52 683	13 698	3 560	69 941	11 905	33 944	115 790
1985	48 672	12 974	3 941	65 587	12 076	38 720	116 383
1986	46 487	12 376	4 887	63 750	10 747	34 936	109 433
1987	45 496	12 181	5 738	63 415	10 406	33 855	107 676
1988	48 277	11 679	5 917	65 873	11 122	33 762	110 757
1989	49 405	11 714	5 881	67 000	11 279	32 696	110 975
1990	45 248	11 515	5 376	62 139	11 017	31 926	105 082
1991	42 092	10 812	5 026	57 930	10 817	31 450	100 197
1992	37 774	10 419	4 338	52 531	9 726	27 678	89 935
1993	34 746	10 500	4 219	49 465	8 860	26 598	84 923
1994	33 380	10 627	5 300	49 307	8 888r	27 693	85 888r
1995	35 182	10 288	6 660	52 130	9 063r	26 491	87 684r
1996	34 257	9 620	6 501	50 378	9 177	34 939	94 494
1997p	33 047	9 751	6 617	49 415	8 995	36 288	94 698
1998f	30 680	9 581	7 763	48 024	7 722	37 869	93 615

Sources: Natural Resources Canada; Statistics Canada.
SIC: Standard Industrial Classification, 1980.
f Forecast; p Preliminary; r Revised.
[1] Total activity includes sales and head offices.

TABLE 26. CANADA, EMPLOYMENT IN THE NON-FUEL MINERAL INDUSTRY, STAGE I – MINERAL EXTRACTION AND CONCENTRATING (TOTAL ACTIVITY),1 1961-98

Year	Gold	Uranium	Iron	Nickel, Copper, Zinc	Silver, Lead, Zinc	Other Nonferrous	Asbestos	Peat	Gypsum	Potash	Salt	Misc. Nonmetals	Other Nonmetals	Stone Quarries	Sand and Gravel	Total Non-Fuel Mineral Industry
SIC no.	0611	0616	0617	0612, 0613	0614	0615, 0619	0621	0622	0623	0624	0625	0629	0625, 0629	081	082	
								(number)								
1961	15 994	(2)	8 446	23 351	4 524	6 278	6 773	1 207	599	(3)	(3)	(3)	2 424	3 173	2 062	74 829
1962	15 425	(2)	9 181	23 383	4 669	5 585	6 936	1 220	594	(3)	(3)	(3)	2 658	3 221	2 293	75 165
1963	14 639	(2)	9 606	22 703	5 163	5 006	6 828	1 303	677	(3)	(3)	(3)	2 853	3 477	2 209	74 468
1964	14 012	(2)	9 544	23 848	5 898	4 346	6 544	1 290	710	(3)	(3)	(3)	3 183	3 718	2 326	75 419
1965	13 155	(2)	11 739	25 892	6 121	4 035	6 536	1 201	646	1 050	(3)	(3)	2 683	3 511	2 737	79 306
1966	11 658	(2)	11 464	27 651	6 356	4 543	6 736	1 254	585	1 195	(3)	(3)	2 652	3 701	2 611	80 404
1967	10 355	(2)	10 899	29 288	6 030	5 156	6 931	1 261	505	1 724	(3)	(3)	2 656	3 381	2 398	80 584
1968	9 001	(2)	11 342	30 557	6 320	6 149	7 213	1 306	489	2 086	(3)	(3)	2 579	3 340	2 496	82 878
1969	8 221	(2)	10 490	28 679	6 467	6 693	7 242	1 156	657	2 713	(3)	(3)	2 554	3 252	2 440	80 564
1970	7 185	(2)	11 336	36 253	7 103	4 713	7 664	1 195	671	2 837	(3)	(3)	2 783	3 023	2 487	87 250
1971	6 148	(2)	11 524	37 713	6 506	4 121	8 101	1 269	603	2 519	(3)	(3)	2 613	2 832	2 496	86 445
1972	5 579	(2)	10 842	36 012	6 057	3 504	7 843	1 114	670	2 440	(3)	(3)	2 799	2 803	2 351	82 014
1973	5 603	(2)	13 395	37 602	6 112	3 422	8 027	1 236	676	2 684	(3)	(3)	2 768	3 097	2 179	86 801
1974	5 665	(2)	15 019	38 876	6 722	3 756	8 131	1 288	671	3 224	(3)	(3)	2 884	3 458	2 739	92 433
1975	5 798	(2)	16 155	35 538	7 362	4 308	6 042	1 303	576	3 351	(3)	(3)	2 431	3 544	2 838	89 246
1976	5 051	3 430	16 765	34 049	7 351	1 623	7 900	1 168	591	3 270	(3)	(3)	2 720	3 217	2 468	89 603
1977	4 643	4 140	15 550	33 703	7 512	1 694	8 302	1 244	652	3 628	(3)	(3)	2 782	3 004	2 186	89 040
1978	4 943	4 965	12 103	25 610	7 073	1 753	7 752	1 295	683	3 708	(3)	(3)	2 597	2 876	1 971	77 329
1979	5 013	5 858	14 563	25 116	7 081	1 329	8 067	1 372	738	3 905	(3)	(3)	2 688	2 860	1 832	80 422
1980	5 839	6 304	13 753	31 063	7 349	1 810	8 055	1 308	715	4 160	(3)	(3)	2 741	2 660	1 801	87 558
1981	6 809	6 869	12 397	33 246	7 740	1 651	6 829	1 441	711	4 661	(3)	(3)	2 749	2 418	1 765	89 286
1982	7 350	6 035	10 676	28 851	6 837	1 754	4 973	1 323	614	4 076	(3)	(3)	2 694	2 028	1 463	78 674
1983	7 956	5 390	8 236	24 953	5 073	586	4 617	1 301	682	3 696	(3)	(3)	2 874	1 980	1 423	68 767
1984	8 450	6 249	7 843	24 000	5 165	976	4 177	1 369	770	4 508	(3)	(3)	2 874	2 256	1 304	69 941
1985	7 862	5 989	7 077	22 073	4 724	947	3 569	1 363	753	4 488	(3)	(3)	2 801	2 340	1 601	65 587
1986	8 562	5 608	6 379	20 616	4 162	1 160	2 766	1 468	990	4 315	(3)	(3)	2 837	2 627	2 260	63 750
1987	9 757	5 289	6 039	18 979	4 372	1 060	2 858	1 510	929	4 094	(3)	(3)	2 790	2 911	2 827	63 415
1988	12 594	5 103	6 095	18 881	4 443	1 161	2 720	1 581	956	3 970	(3)	(3)	2 452	2 981	2 936	65 873
1989	12 631	4 839	6 303	19 837	4 487	1 308	2 800	1 713	965	3 893	(3)	(3)	2 343	3 145	2 736	67 000
1990	11 807	3 702	5 820	19 104	3 727	1 088	2 699	1 740	786	3 822	(3)	(3)	2 468	2 951	2 425	62 139
1991	10 869	2 391	5 683	18 634	3 459	1 056	2 423	1 519	636	3 825	1 575	834	2 409	2 774	2 252	57 930
1992	9 403	1 702	5 090	17 128	3 664	787	2 289	1 448	672	3 779	1 520	711	2 231	2 496	1 842	52 531
1993	8 810	1 467	4 648	15 892	3 134	795	2 253	1 624	698	3 657	1 547	721	2 268	2 448	1 771	49 465
1994	9 192	1 503	4 700	14 463	2 645	877	2 159	1 928	693	3 644	1 518	685	2 203	2 681	2 619	49 307
1995	9 849	1 530	4 852	15 059	2 898	994	x	1 951	689	3 573	1 433	x	x	2 981	3 679	52 130
1996	10 099	1 299	4 736	14 074	3 061	988	x	1 485	691	3 506	1 308	x	x	2 914	3 587	50 378
1997p	9 656	1 024	4 839	13 478	3 058	992	x	1 536	651	3 444	1 466	x	x	2 965	3 652	49 415
1998f	8 964pr	951pr	4 492pr	12 513pr	2 839pr	921pr	x	1 509pr	640pr	3 384pr	1 440pr	x	x	3 848	3 915	48 024

Sources: Natural Resources Canada; Statistics Canada.
SIC: Standard Industrial Classification, 1980.
f Forecast; p Preliminary; pr Pro-rated; x Confidential.
1 Total activity includes sales and head offices. (2) Included in "Other Nonferrous." (3) Included in "Other Nonmetals."
Note: Numbers may not add to totals due to rounding.

TABLE 27. CANADA, EMPLOYMENT IN THE MINERAL INDUSTRY, STAGE II – SMELTING AND REFINING (TOTAL ACTIVITY),[1] 1961-98

Year	Smelting/ Refining	Iron and Steel Mills	Total Primary Metals	Petroleum Refineries	Total Smelting and Refining
SIC no.	295	291	291, 295	3611	
			(number)		
1961	29 938	34 749	64 687	10 660	75 347
1962	29 693	36 593	66 286	10 184	76 470
1963	28 516	38 196	66 712	9 734	76 446
1964	30 153	41 505	71 658	9 547	81 205
1965	31 835	44 274	76 109	8 976	85 085
1966	34 237	45 999	80 236	8 996	89 232
1967	34 764	44 203	78 967	9 147	88 114
1968	34 710	44 634	79 344	9 091	88 435
1969	33 376	42 954	76 330	8 765	85 095
1970	37 298	49 169	86 467	14 725	101 192
1971	36 445	49 601	86 046	14 506	100 552
1972	33 829	49 758	83 587	14 376	97 963
1973	32 396	53 008	85 404	14 843	100 247
1974	35 249	54 253	89 502	15 967	105 469
1975	35 577	54 003	89 580	15 624	105 204
1976	34 246	51 978	86 224	15 105	101 329
1977	35 647	52 709	88 356	16 464	104 820
1978	32 652	56 669	89 321	18 958	108 279
1979	32 869	59 167	92 036	18 037	110 073
1980	36 137	61 238	97 375	18 743	116 118
1981	38 011	56 543	94 554	21 325	115 879
1982	33 215	52 330	85 545	20 155	105 700
1983	31 788	47 693	79 481	17 557	97 038
1984	31 752	48 899	80 651	15 847	96 498
1985	30 567	47 685	78 252	15 326	93 578
1986	29 058	46 461	75 519	13 287	88 806
1987	29 397	46 493	75 890	13 252	89 142
1988	30 099	48 259	78 358	13 358	91 716
1989	30 651	46 738	77 389	13 881	91 270
1990	30 573	39 120	69 693	13 820	83 513
1991	28 817	38 126	66 943■	12 459	79 402
1992	27 837	35 268	63 105	11 032	74 137
1993	26 175	33 327	59 502	10 819	70 321
1994	24 231	33 097	57 328	10 262	67 590
1995	25 763	32 844	58 607	9 329	67 936
1996	26 529	32 190	58 719	9 303	68 022
1997•	26 489	32 112	58 601	8 772pr	67 372
1998f	26 541	33 047	59 588	9 143pr	68 731

Sources: Natural Resources Canada; Statistics Canada.
SIC: Standard Industrial Classification, 1980.
• Estimated; f Forecast; pr Pro-rated.
■ Change is partially due to the reclassification of a unit from SIC 295 to SIC 296 effective May 1991.
1 Total activity includes sales and head offices.
Note: Numbers may not add to totals due to rounding.

TABLE 28. CANADA, EMPLOYMENT IN THE MINERAL INDUSTRY, STAGE III – SEMI-FABRICATION (TOTAL ACTIVITY),[1] 1961-98

Year	Total Non-Fuel Semi-Fabrication	Miscellaneous Petroleum and Coal Products	Lubricating Oil and Greases	Total Semi-Fabrication
SIC no.[2]		369	3612	
		(number)		
1961	77 063	581	331	77 975
1962	80 606	608	352	81 566
1963	82 420	635	354	83 409
1964	87 843	726	373	88 942
1965	93 912	531	408	94 851
1966	98 602	585	424	99 611
1967	96 033	546	407	96 986
1968	96 375	518	397	97 290
1969	99 438	532	438	100 408
1970	96 144	499	423	97 066
1971	95 831	561	450	96 842
1972	101 109	555	478	102 142
1973	105 884	757	487	107 128
1974	109 818	954	514	111 286
1975	104 296	984	656	105 936
1976	103 411	982	602	104 995
1977	101 257	716	669	102 642
1978	107 234	683	712	108 629
1979	111 231	461	695	112 387
1980	105 902	532	798	107 232
1981	103 192	584	729	104 505
1982	90 194	571	792	91 557
1983	86 814	503	857	88 174
1984	91 405	521	896	92 822
1985	94 515	513	900	95 928
1986	96 744	778	1 001	98 523
1987	99 963	894	1 002	101 859
1988	103 307	1 161	1 091	105 559
1989	101 419	1 135	1 029	103 583
1990	94 544	1 000	1 048	96 592
1991	87 091	1 138	1 046	89 275
1992	81 001	1 390	993	83 384
1993	79 389	1 401	1 864	82 654
1994	80 886	1 415	1 877	84 178
1995	83 931	1 444	1 569	86 944
1996	83 366	1 521	1 567	86 454
1997e	87 247	1 665	1 477pr	90 389
1998f	94 134	2 222	1 540pr	97 896

Sources: Natural Resources Canada; Statistics Canada.
SIC: Standard Industrial Classification, 1980.
e Estimated; f Forecast; pr Pro-rated.
[1] Includes sales and head offices. [2] 1970 SIC for years 1961-82.
Note: Numbers may not add to totals due to rounding.

TABLE 29. CANADA, EMPLOYMENT IN THE MINERAL INDUSTRY, STAGE III – NON-FUEL SEMI-FABRICATION (TOTAL ACTIVITY),[1] 1961-98

Year	Steel Pipe and Tube	Iron Foundries	Aluminum Rolling, Casting, Extruding	Copper Rolling, Casting, Extruding	Other Rolling, Casting, Extruding	Wire and Wire Products	Clay and Clay Products	Cement	Concrete Products	Ready-Mix Concrete	Glass and Glass Products[2]	Abrasives	Lime	Other Non-metallic Products	Total Non-Fuel Semi-Fabrication
SIC no.	292	294	296	297	299	305	351	352	354	355	356	357	358	359	
								(number)							
1961	3 407	8 178	5 095	3 482	2 731	12 227	5 327	3 590	8 503	4 232	9 802	2 481	847	7 161	77 063
1962	3 676	8 546	5 118	3 492	2 770	13 045	5 468	3 679	9 156	4 886	10 042	2 577	949	7 202	80 606
1963	3 840	8 216	5 164	3 651	3 038	13 743	5 376	3 566	9 317	5 411	10 346	2 464	886	7 402	82 420
1964	4 437	9 620	4 834	3 849	3 382	14 850	5 582	3 592	10 225	6 171	10 362	2 580	815	7 544	87 843
1965	4 799	11 714	4 654	3 620	3 736	16 099	5 675	3 837	10 988	6 559	10 873	2 821	800	7 737	93 912
1966	4 795	13 027	4 943	4 199	4 103	16 391	5 876	4 053	11 090	7 349	11 248	3 044	785	7 699	98 602
1967	5 012	11 970	5 468	4 027	4 287	16 060	5 559	3 972	10 321	7 137	11 388	2 734	724	7 374	96 033
1968	5 441	11 131	5 491	3 947	4 585	16 082	5 515	3 747	10 166	7 440	11 992	2 617	662	7 559	96 375
1969	5 146	11 582	6 028	3 922	4 856	17 014	5 383	3 778	11 011	7 509	12 031	2 697	707	7 774	99 438
1970	5 314	10 663	6 297	3 744	4 060	16 598	4 938	3 887	9 562	7 340	11 654	2 559	660	8 868	96 144
1971	5 306	9 897	5 612	3 608	3 845	16 272	4 682	3 954	10 719	7 997	11 672	2 310	670	9 287	95 831
1972	6 268	9 948	6 200	3 740	4 215	17 651	4 695	4 732	10 817	8 240	12 045	2 367	651	9 540	101109
1973	5 268	10 965	6 206	3 736	4 863	18 877	5 001	4 871	10 790	9 233	12 840	2 555	724	9 935	105 884
1974	5 845	12 054	6 162	3 779	4 877	19 535	5 289	4 666	11 602	9 219	12 915	2 676	840	10 359	109 818
1975	5 785	11 480	5 672	3 240	4 573	17 614	5 042	4 577	11 201	9 541	11 779	2 318	790	10 684	104 296
1976	5 546	10 365	6 255	3 297	5 354	17 573	4 791	4 517	10 773	9 128	11 836	2 535	804	10 637	103 411
1977	5 634	10 459	6 884	3 183	4 703	17 886	4 553	4 265	10 001	8 521	11 204	2 557	828	10 579	101 257
1978	6 289	10 472	7 060	3 586	5 268	18 823	4 366	4 520	10 486	9 520	11 595	2 678	784	11 787	107 234
1979	6 480	10 520	7 698	3 728	6 292	19 765	4 947	4 828	9 766	9 332	11 835	2 650	925	12 455	111 231
1980	6 514	9 245	6 627	3 230	5 749	18 529	4 875	4 791	9 280	9 348	11 967	2 628	1 003	12 116	105 902
1981	7 531	8 358	6 512	3 031	5 182	17 309	4 145	4 726	9 121	10 053	12 003	2 571	968	11 682	103 192
1982	6 017	8 163	6 255	2 541	4 694	14 575	3 004	4 317	8 245	8 034	11 016	2 170	895	10 268	90 194
1983	4 521	7 364	6 415	2 744	4 827	13 493	3 008	4 057	7 286	8 390	11 896	1 852	862	10 099	88 814
1984	5 482	7 911	6 661	2 971	5 274	14 212	3 070	3 771	7 657	8 802	12 754	1 949	876	10 015	91 405
1985	5 978	7 750	6 196	3 012	5 620	15 354	2 727	3 533	8 336	9 210	12 872	1 895	783	11 249	94 515
1986	4 829	7 547	6 200	3 059	6 357	15 262	3 770	3 514	9 174	10 422	13 448	1 827	778	10 557	96 744
1987	4 964	7 860	6 143	2 828	6 403	14 943	3 930	3 646	10 309	11 910	13 605	1 693	784	10 945	99 963
1988	6 008	8 095	6 124	3 040	7 049	15 154	3 261	3 388	11 386	12 461	13 338	1 917	873	11 215	103 307
1989	5 438	7 538	6 285	3 119	6 645	15 077	3 044	3 350	11 505	12 377	12 664	2 039	871	11 467	101 419
1990	5 319	8 397	5 463	2 316	5 479	12 965	2 563	3 259	10 627	12 798	11 733	1 837	836	10 952	94 544
1991	5 618	7 680	5 169	2 211	4 710	12 369	2 254	3 111	9 442	11 633	10 855	1 408	861	9 770	87 091
1992	4 808	7 394	4 998	2 066	5 100	11 560	2 204	2 962	7 741	10 962	10 053	1 523	771	8 819	81 001
1993	5 555	7 174	5 128	2 111	4 946	11 814	1 686	2 786	7 387	10 438	9 676	1 395	731	8 562	79 389
1994	5 889	7 412	5 763	2 092	5 431	12 386	1 647	2 762	7 195	10 389	9 359	1 335	763	8 463	80 886
1995	5 675	7 736	5 713	2 023	6 043	13 249	1 762	2 784	8 000	10 233	9 542	1 451	793	8 927	83 931
1996	6 014	7 002	6 036	2 100	6 370	12 548	1 714	2 659	7 552	10 488	9 836	1 247	741	9 059	83 366
1997e	5 433	5 708	7 461	2 421	6 746	13 449	1 766	2 860	9 205	11 245	9 570	1 285	763	9 334	87 247
1998f	5 732	6 368	8 168	2 711	6 771	14 656	1 925	3 117	9 808	12 176	10 294	1 401	832	10 175	94 134

Sources: Natural Resources Canada; Statistics Canada.
SIC: Standard Industrial Classification, 1980.
e Estimated; f Forecast.
1 Includes sales and head offices. 2 Includes sealed window manufacturers until 1969; thereafter, these are included in Stage IV – Ornamental Metal Products.
Note: Numbers may not add to totals due to rounding.

TABLE 30. CANADA, EMPLOYMENT IN THE MINERAL INDUSTRY, STAGE IV – METALLIC MINERAL MANUFACTURING (TOTAL ACTIVITY),[1] 1961-98

Year	Boilers	Structural Metal Products	Ornamental Metal Products	Stamped, Pressed and Coated Products	Hardware Tools and Cutlery	Heating Equipment	Machine Parts	Other Metal Fabricating	Total Mineral Manufacturing
SIC no.	301	302	303	304	306	307	308	309	
					(number)				
1961	4 709	14 231	10 641	21 156	9 135	5 137	7 756	15 249	88 014
1962	4 886	14 802	11 640	23 606	10 223	5 349	8 603	16 283	95 392
1963	5 350	14 212	12 459	24 024	11 112	5 586	9 179	16 627	98 549
1964	5 429	14 602	12 808	25 192	13 110	5 673	10 137	18 088	105 039
1965	6 496	18 072	13 439	27 925	13 570	5 711	11 618	20 017	116 848
1966	7 239	21 038	13 488	29 577	14 326	5 464	13 235	21 431	125 798
1967	6 622	18 547	12 994	29 830	14 056	5 461	13 810	21 007	122 327
1968	7 962	17 150	12 664	29 560	14 166	4 930	13 501	20 825	120 758
1969	7 494	18 203	12 784	30 463	14 401	5 059	14 517	20 895	123 816
1970	7 661	19 104	12 417	29 709	15 241	4 670	14 221	20 543	123 566
1971	7 847	17 556	12 614	28 710	14 920	4 749	13 097	20 755	120 248
1972	8 136	17 113	13 611	27 939	16 386	4 238	11 731	21 504	120 658
1973	8 013	18 164	13 937	30 026	18 819	4 453	10 138	22 494	126 044
1974	8 681	20 020	14 470	31 276	20 234	4 930	10 936	23 663	134 210
1975	10 211	19 101	15 241	30 273	18 990	4 717	10 922	23 810	133 265
1976	10 704	18 056	15 541	31 487	19 316	4 977	10 764	23 704	134 549
1977	9 660	17 209	14 800	30 888	17 867	4 538	10 762	23 298	129 022
1978	9 124	16 759	16 753	34 181	18 856	5 086	12 029	24 904	137 692
1979	9 477	18 676	18 018	33 548	21 090	5 818	13 081	23 705	143 413
1980	10 374	17 700	17 890	32 266	20 830	5 993	13 449	24 217	142 719
1981	11 215	18 445	17 603	32 459	19 575	5 806	14 297	22 123	141 523
1982	10 965	17 021	15 228	29 865	17 342	5 317	13 083	18 167	126 988
1983	5 413	18 437	13 537	27 947	16 609	5 032	12 881	16 044	115 900
1984	4 548	17 162	13 538	27 758	17 308	4 220	14 200	16 256	114 990
1985	4 455	18 083	15 598	31 021	19 297	5 607	15 356	14 927	124 344
1986	4 990	19 213	17 462	31 584	21 164	5 779	17 259	15 170	132 621
1987	4 816	18 615	19 770	35 329	22 129	6 252	18 398	16 358	141 667
1988	6 182	19 689	20 795	36 976	23 042	6 390	22 681	17 887	153 642
1989	5 407	23 006	22 591	36 707	25 626	7 076	24 639	20 099	165 151
1990	5 234	21 277	21 075	33 665	22 475	6 112	24 271	19 298	153 407
1991	5 081	18 667	19 885	30 348	21 912	5 246	23 092	16 770	141 001
1992	5 557	15 236	16 523	28 512	19 084	4 187	18 374	15 312	122 785
1993	5 277	14 769	14 554	28 396	20 051	4 463	18 840	14 442	120 792
1994	5 167	15 342	14 484	29 518	21 716	4 919	21 290	15 630	128 066
1995	5 012	17 706	14 501	31 562	22 704	5 280	24 691	17 258	138 714
1996	3 278	18 461	15 037	30 615	23 088	4 836	26 180	16 386	137 881
1997•	2 756	20 957	14 081	33 601	25 460	4 079	28 099	19 595	148 627
1998[f]	2 542	23 714	15 045	34 213	28 556	4 462	28 315	20 917	157 764

Sources: Natural Resources Canada; Statistics Canada.
SIC: Standard Industrial Classification, 1980.
• Estimated; [f] Forecast.
[1] Total activity includes sales and head offices.
Note: Numbers may not add to totals due to rounding.

TABLE 31. CANADA, EMPLOYMENT FOR SERVICES INCIDENTAL TO MINES, QUARRIES AND OIL WELLS, 1961-98[a]

Year	Petroleum and Natural Gas Contract Drilling	Mining Diamond Drilling	Other Services Incidental to Mines, Quarries and Oil Wells	Total
	(number)			
1961	4 144	2 025	1 409	7 578
1962	3 800	1 926	1 720	7 446
1963	4 179	2 201	1 491	7 871
1964	4 158	2 401	2 077	8 636
1965	4 648	2 776	3 137	10 561
1966	4 428	2 887	4 317	11 632
1967	4 249	2 669	5 425	12 343
1968	4 434	2 985	6 350	13 769
1969	4 821	3 109	6 967	14 897
1970	4 267	3 207	7 894	15 368
1971	4 093	2 514	7 710	14 317
1972	4 817	2 083	6 139	13 039
1973	5 680	2 123	5 193	12 996
1974	5 054	2 317	5 017	12 388
1975	5 096	1 899	4 139	11 134
1976	5 486	1 548	5 043	12 077
1977	6 054	1 682	5 723	13 459
1978	7 419	1 681	7 492	16 592
1979	9 076	2 420	8 436	19 932
1980	11 097	2 959	9 327	23 383
1981	8 448	2 721	9 856	21 025
1982	6 882	1 880	7 752	16 514
1983	12 032	1 575	12 254	25 861
1984	33 577	1 684	10 602	45 863
1985	37 516	1 625	12 191	51 332
1986	31 480	2 198	11 582	45 260
1987	30 400	3 353	11 174	44 928
1988	32 376	3 201	12 384	47 961
1989	29 017	2 072	11 052	42 141
1990	28 138	1 848	9 540	39 525
1991	29 909	1 395	8 606	39 910
1992	23 074	1 143	6 957	31 174
1993	25 426	1 515	6 284	33 225
1994	32 909	1 744	7 810	42 463
1995	28 177	1 832	8 041	38 050
1996	26 354	2 155	8 488	36 998
1997[p]	32 150	2 124	8 738	43 012
1998[f]	34 964	2 124	7 585	44 672

Sources: Natural Resources Canada; Statistics Canada.
SIC: Standard Industrial Classification, 1980.
[f] Forecast; [p] Preliminary.
[a] From 1961 to 1983, Petroleum and Natural Gas Contract Drilling included SIC Code 0911, Mining Diamond Drilling included SIC Code 0921, and Other Services Incidental to Mines, Quarries and Oil Wells included both SIC Codes 0919 and 0929. For data beginning in the year 1984, these series changed. Petroleum and Natural Gas Contract Drilling includes both SIC Codes 0911 and 0919, Mining Diamond Drilling includes SIC Code 0921, and Other Services Incidental to Mines and Quarries (excluding Oil Wells) includes SIC Code 0929 only.
Note: Numbers may not add to totals due to rounding.

TABLE 32. CANADA, EMPLOYMENT, SALARIES AND WAGES IN THE MINERAL INDUSTRY,[1] 1989-96

	Unit	1989	1990	1991	1992	1993	1994	1995	1996
METALS									
Production and related workers	Number	37 451	33 895	31 168	27 908	25 762	24 809	26 344	25 830
Salaries and wages	$000	1 707 653	1 674 050	1 627 254	1 532 118	1 374 090	1 376 286	1 500 141	1 533 204
Average annual salary and wage	$	45 597	49 389	52 209	54 899	53 338	55 475	56 944	59 357
Administrative and office workers	Number	11 835	11 353	10 924	9 866	8 984	8 571	8 838	8 427
Salaries and wages	$000	592 921	603 486	626 302	587 210	532 735	526 076	558 984	554 226
Average annual salary and wage	$	50 099	53 157	57 333	59 519	59 298	61 379	63 248	65 768
Total metals									
Employees	Number	49 405	45 248	42 092	37 774	34 746r	33 380	35 182	34 257
Salaries and wages	$000	2 307 891	2 277 536	2 253 556	2 119 328	1 906 825	1 902 362	2 059 125	2 087 429
Average annual salary and wage	$	46 714	50 335	53 539	56 105	54 879	56 991	58 528	60 934
NONMETALS[2]									
Production and related workers	Number	8 730	8 736	8 055	7 938	7 974	8 094	7 855	7 232
Salaries and wages	$000	298 008	300 325	301 481	313 175	316 207	336 277	346 297	331 027
Average annual salary and wage	$	34 136	34 378	37 428	39 453	39 655	41 548	44 086	45 772
Administrative and office workers	Number	2 984	2 779	2 757	2 481	2 526	2 533	2 433	2 388
Salaries and wages	$000	127 774	125 740	133 255	122 356	125 008	124 704	127 452	129 484
Average annual salary and wage	$	42 820	45 246	48 333	49 317	49 489	49 232	52 385	54 223
Total nonmetals									
Employees	Number	11 714	11 515	10 812	10 419	10 500	10 627	10 288	9 620
Salaries and wages	$000	425 783	426 064	434 736	435 531	441 215	460 981	473 749	460 511
Average annual salary and wage	$	36 348	37 001	40 209	41 802	42 020	43 378	46 049	47 870
MINERAL FUELS (COAL)									
Production and related workers	Number	9 166	8 961	8 775	7 804	7 204	7 272	7 423	7 458
Salaries and wages	$000	414 402	398 043	391 289	319 110	334 274	371 786	384 630	418 016
Average annual salary and wage	$	45 211	44 419	44 591	40 891	46 401	51 126	51 816	56 049
Administrative and office workers	Number	2 113	2 056	2 042	1 922	1 656	1 616	1 640	1 719
Salaries and wages	$000	106 050	95 426	103 853	98 604	85 078	87 713	93 402	93 808
Average annual salary and wage	$	50 189	46 413	50 858	51 303	51 376	54 278	56 952	54 471
Total mineral fuels									
Employees	Number	11 279	11 017	10 817	9 726	8 860	8 888r	9 063r	9 177
Salaries and wages	$000	520 452	493 469	495 142	417 714	419 352	459 499r	478 032r	511 824
Average annual salary and wage	$	46 143	44 792	45 774	42 948	47 331	51 699r	52 745r	55 772
STRUCTURAL MATERIALS									
Production and related workers	Number	4 246	3 966	3 644	3 169	3 113	3 908	5 106	4 956
Salaries and wages	$000	142 742	138 400	126 030	114 101	115 333	143 405	190 206	184 265
Average annual salary and wage	$	33 618	34 897	34 586	36 005	37 049	36 695	37 251	37 180
Administrative and office workers	Number	1 635	1 413	1 382	1 169	1 106	1 392	1 554	1 545
Salaries and wages	$000	63 783	55 682	53 655	50 121	46 068	53 559	61 363	62 342
Average annual salary and wage	$	39 011	39 407	38 824	42 875	41 653	38 476	39 487	40 363
Total structural materials									
Employees	Number	5 881	5 376	5 026	4 338	4 219	5 300	6 660	6 501
Salaries and wages	$000	206 525	194 081	179 685	164 222	161 401	196 964	251 569	246 607
Average annual salary and wage	$	35 117	36 101	35 751	37 857	38 256	37 163	37 773	37 931
TOTAL MINERAL INDUSTRY									
Production and related workers	Number	59 593	55 558	51 642	46 819	44 053	44 083	46 728	45 476
Salaries and wages	$000	2 562 805	2 510 817	2 446 055	2 278 504	2 139 903	2 227 755	2 421 274	2 466 512
Average annual salary and wage	$	43 005	45 193	47 366	48 666	48 576	50 535	51 816	54 238
Administrative and office workers	Number	18 567	17 601	17 105	15 438	14 272	14 112	14 465	14 079
Salaries and wages	$000	890 528	880 333	917 064	858 290	788 890	792 052	841 201	839 860
Average annual salary and wage	$	47 963	50 016	53 614	55 596	55 275	56 126	58 154	59 655
Total mineral industry									
Employees	Number	78 279	73 158	68 747	62 247	58 325	58 195r	61 193r	59 555
Salaries and wages	$000	3 460 651	3 391 151	3 363 119	3 136 794	2 928 793	3 019 806r	3 262 475r	3 306 371
Average annual salary and wage	$	44 209	46 355	48 920	50 385	50 215	51 890r	53 315r	55 518

Sources: Natural Resources Canada; Statistics Canada.
r Revised.
[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. [2] Includes structural materials.
Notes: This table no longer includes data for the petroleum and natural gas industries. Numbers may not add to totals due to rounding.

TABLE 33. CANADA, NUMBER OF WAGE EARNERS EMPLOYED IN THE NON-FUEL MINERAL INDUSTRY (SURFACE, UNDERGROUND AND MILL), 1989-96

	1989	1990	1991	1992	1993	1994	1995	1996
				(number)				
METALS								
Surface	9 358	8 608	7 545	6 550	5 973	4 526	4 467	6 358
Underground	16 116	14 454	13 614	12 205	11 281	11 396	12 305	10 610
Mill	11 977	10 833	10 009	9 153	8 508	8 888	9 572	8 862
Total	37 451	33 895	31 168	27 908	25 762	24 810	26 344	25 830
NONMETALS								
Surface	2 101	2 039	1 719	1 785	1 912	1 945	1 796	1 702
Underground	2 251	2 309	2 214	2 125	2 098	2 093	1 967	1 926
Mill	4 378	4 388	4 122	4 028	3 964	4 056	4 092	3 604
Total	8 730	8 736	8 055	7 938	7 974	8 094	7 855	7 232
STRUCTURAL MATERIALS								
Surface	3 643	3 348	3 181	2 768	2 708	3 373	4 573	4 349
Underground	–	–	–	–	–	–	–	–
Mill	603	618	463	401	405	535	533	607
Total	4 246	3 966	3 644	3 169	3 113	3 908	5 106	4 956
TOTAL NON-FUEL MINERAL INDUSTRY								
Surface	15 102	13 995	12 445	11 103	10 593	9 844	10 836	12 409
Underground	18 367	16 763	15 828	14 330	13 379	13 489	14 272	12 536
Mill	16 958	15 839	14 594	13 582	12 877	13 479	14 197	13 073
Total	50 427	46 597	42 867	39 015	36 849	36 812	39 305	38 018

Source: Natural Resources Canada.
– Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 34. CANADA, MINE AND MILL WORKERS, BY SEX, EMPLOYED IN THE NON-FUEL MINERAL INDUSTRY, 1996

	Mine Workers				Mill Workers		Total	
	Underground		Surface					
	Male	Female	Male	Female	Male	Female	Male	Female
				(number)				
METALS								
Gold	2 828	48	2 448	26	2 163	82	7 439	156
Silver-lead-zinc	949	6	562	36	536	40	2 047	82
Uranium	216	17	280	14	476	28	972	59
Iron ore	29	–	927	18	2 433	104	3 389	122
Nickel-copper-zinc[1]	6 375	45	1 700	62	2 619	122	10 694	229
Miscellaneous metal mines[2]	97	–	278	7	249	10	624	17
Total	10 494	116	6 195	163	8 476	386	25 165	665
NONMETALS								
Asbestos	x	x	x	x	x	x	x	x
Peat	–	–	369	31	757	31	1 126	62
Gypsum	115	–	395	–	77	3	587	3
Potash	1 264	12	15	–	1 223	37	2 502	49
Miscellaneous nonmetal mines[3]	x	x	x	x	x	x	x	x
Total	1 914	12	1 663	39	3 508	96	7 085	147
STRUCTURAL MATERIALS								
Stone	–	–	1 764	23	395	14	2 159	37
Sand and gravel	–	–	2 487	75	196	2	2 683	77
Total	–	–	4 251	98	591	16	4 842	114
Total non-fuel mineral industry[4]	12 408	128	12 109	300	12 575	498	37 092	926

Source: Natural Resources Canada.
– Nil; x Confidential.
1 Includes copper-zinc and nickel-copper mines. 2 Includes molybdenum mines. 3 Includes salt mines. 4 Coal data are not available.

TABLE 35. CANADA, LABOUR COSTS FOR METAL MINES IN RELATION TO TONNES MINED, 1994-96

	Number of Wage Earners	Total Wages	Average Annual Wage	Tonnage of Ore Mined	Average Annual Tonnes Mined Per Wage Earner	Wage Cost Per Tonne Mined
	(no.)	($000)	($)	(000 tonnes)	(tonnes)	($)
1994						
Uranium	642	33 359	51 961	1 756	2 734	19.00
Gold	4 913	276 067	56 191	21 288	4 333	12.97
Silver-lead-zinc	1 276	47 230	37 014	7 444	5 834	6.34
Nickel-copper-zinc[1]	7 713	432 839	56 118	92 651	12 012	4.67
Miscellaneous metals[2]	392	18 546	47 310	14 887	37 977	1.25
Iron ore	986	74 443	75 500	95 723	97 082	0.78
Total	15 922	882 484	55 425	233 748	14 681	3.78
1995						
Uranium	639	33 163	51 898	1 364	2 135	24.31
Gold	5 265	305 233	57 974	25 120	4 771	12.15
Silver-lead-zinc	1 350	70 554	52 263	10 295	7 626	6 .85
Nickel-copper-zinc[1]	8 131	462 806	56 919	113 260	13 929	4 .09
Miscellaneous metals[2]	382	18 005	47 132	14 899	39 002	1.21
Iron ore	1 005	78 680	78 289	95 538	95 063	0.82
Total	16 772	968 441	57 742	260 475	15 530	3.72
1996						
Uranium	527	28 245	53 595	1 333	2 530	21.18
Gold	5 350	330 486	61 773	30 901	5 775	10.70
Silver-lead-zinc	1 553	83 214	53 583	11 656	7 505	7.14
Nickel-copper-zinc[1]	8 182	463 280	56 622	98 671	12 059	4.70
Miscellaneous metals[2]	382	20 020	52 407	14 659	38 374	1.37
Iron ore	974	76 455	78 496	95 783	98 339	0.80
Total	16 968	1 001 699	59 035	253 003	14 910	3.96

Source: Natural Resources Canada.
[1] Includes copper-zinc and nickel-copper mines. [2] Includes molybdenum mines.

TABLE 36. CANADA, PERSON-HOURS PAID FOR PRODUCTION AND RELATED WORKERS, AND TONNES OF ORE MINED AND ROCK QUARRIED IN METAL MINES AND OTHER MINERAL OPERATIONS, 1991-96

	Unit	1991	1992	1993	1994	1995	1996
METAL MINES[1]							
Ore mined	Mt	271.4	248.2	236.5	233.7	260.5	253.0
Person-hours paid[2]	million	68.7	61.1	55.5	53.7	57.1	56.1
Person-hours paid per tonne mined	number	0.25	0.25	0.23	0.23	0.22	0.22
Tonnes mined per person-hour paid	t	3.95	4.06	4.26	4.35	4.56	4.50
OTHER MINERAL OPERATIONS[3]							
Ore mined and rock quarried	Mt	156.8	147.8	151.7[r]	170.5	173.0	167.9
Person-hours paid[2]	million	32.5	30.1	32.2[r]	32.2	33.3	32.1
Person-hours paid per tonne mined	number	0.21	0.20	0.21[r]	0.19	0.19	0.19
Tonnes mined per person-hour paid	t	4.82	4.91	4.71[r]	5.29	5.20	5.23

Sources: Natural Resources Canada; Statistics Canada, catalogue nos. 26-223, 26-224 and 26-206.
[r] Revised.
[1] Excludes placer mining. [2] Person-hours paid for production and related workers only. [3] Includes asbestos, potash, gypsum, salt, miscellaneous nonmetals, and coal.

TABLE 37. CANADA, AVERAGE WEEKLY WAGES (INCLUDING OVERTIME) FOR HOURLY RATED EMPLOYEES IN THE MINING, MINERAL MANUFACTURING, AND LOGGING AND FORESTRY INDUSTRIES, 1990-98

	1990	1991	1992	1993	1994	1995	1996	1997	1998
					($)				
Mines, quarries and oil wells	858.18	902.75	929.47	953.46	960.83	991.43	1 039.08	1 057.61	1 053.70
Mining	849.63	893.99	934.52	946.41	972.67	1 013.75	1 051.24	1 036.86	1 101.80
Metal mines	876.74	928.68	972.31	988.59	1 016.75	1 068.15	1 109.27	1 084.60	1 165.38
Nonmetal mines	723.67	760.42	795.46	802.00	830.51	845.53	871.52	910.50	920.56
Quarries and sand pits	621.74	650.78	672.02	640.86	669.64	724.13	746.72	781.99	845.45
Coal mines	867.60	897.50	933.84	946.45	956.98	990.84	1 015.54	994.15	1 071.30
Crude petroleum and natural gas	1 043.34	1 110.13	1 098.68	1 148.77	1 165.58	1 202.52	1 243.35	1 252.89	1 297.23
Logging and forestry	645.91	682.45	700.07	712.49	733.88	735.30	768.63	793.12	787.91
Manufacturing	599.37	624.70	652.92	669.44	685.84	694.58	716.62	736.69	755.92

Source: Statistics Canada.

TABLE 38. CANADA, NUMBER OF STRIKES AND LOCKOUTS BY INDUSTRY, 1996-98

	1996			1997			1998p		
	Strikes and Lockouts	Workers Involved	Duration in Person-Days	Strikes and Lockouts	Workers Involved	Duration in Person-Days	Strikes and Lockouts	Workers Involved	Duration in Person-Days
					(number)				
Agriculture	1	5	450	–	–	–	–	–	–
Logging and forestry	2	465	4 310	1	9	710	4	4 870	476 650
Fishing and trapping	2	25	235	–	–	–	–	–	–
Mining	8	3 984	133 960	7	6 175	164 100	7	768	92 050
Manufacturing	102	38 021	763 719	112	23 003	778 280	111	22 968	601 483
Construction	11	3 825	92 389	–	–	–	15	11 242	325 840
Transportation and utilities	33	10 030	245 290	39	48 728	594 660	29	5 791	108 180
Trade	41	19 355	424 335	30	11 160	461 190	40	1 763	43 900
Finance, insurance and real estate	3	49	2 975	4	73	2 070	14	1 364	41 700
Service	106	28 134	418 947	78	140 177	1 537 166	133	171 285	682 190
Public administration	15	49 851	1 122 950	12	3 337	46 600	21	3 890	82 370
Other industries	4	130 000	130 000	1	25 000	25 000	3	9 012	9 360
Total, all industries	328	283 744	3 339 560	284	257 662	3 609 776	377	232 953	2 463 723

Source: Human Resources Development Canada, Workplace Information Directorate.
– Nil; p Preliminary.

TABLE 39. CANADA, NUMBER OF STRIKES AND LOCKOUTS BY MINING AND MINERAL MANUFACTURING INDUSTRY, 1996-98

	1996			1997			1998p		
	Strikes and Lockouts	Workers Involved	Duration in Person-Days	Strikes and Lockouts	Workers Involved	Duration in Person-Days	Strikes and Lockouts	Workers Involved	Duration in Person-Days
					(number)				
MINING	8	3 984	133 960	7	6 175	164 100	7	768	92 050
Metals	5	3 654	100 880	3	6 087	154 840	3	486	76 430
Mineral fuels	–	–	–	–	–	–	1	100	100
Nonmetals	2	303	29 520	2	34	2 410	2	155	8 630
Quarries	1	27	3 560	2	54	6 850	1	27	6 890
MINERAL MANUFACTURING	15	2 300	75 510	11	2 383	86 420	13	1 358	23 210
Primary metals	5	977	27 260	6	1 588	64 190	6	1 072	3 940
Nonmetallic mineral products	9	1 158	22 670	5	795	22 230	7	284	19 270
Petroleum and coal products	1	165	25 580	–	–	–	–	–	–

Source: Human Resources Development Canada, Workplace Information Directorate.
– Nil; p Preliminary.

TABLE 40. CANADA, MINING WAGES AND SALARIES BY PROVINCE, TERRITORY AND MINERAL CLASS, 1995 AND 1996

Province/Territory	1995 Metals	1995 Nonmetals	1995 Coal	1995 Quarries and Sand Pits	1995 Total	1996 Metals	1996 Nonmetals	1996 Coal	1996 Quarries and Sand Pits	1996 Total
					($000)					
Newfoundland	166 110	x	–	x	168 223	168 242	x	–	x	170 078
Prince Edward Island	–	695	–	–	695	–	649	–	–	649
Nova Scotia	400	27 570	70 352	6 062	104 383	–	29 606	69 956	6 075	105 637
New Brunswick	x	x	4 280	4 309	134 003	x	x	4 245	4 548	135 672
Quebec	496 836	123 136	–	61 282	681 254	516 416	110 051	–	56 473	682 940
Ontario	690 667	60 999	–	105 600	857 266	665 665	63 678	–	104 341	833 684
Manitoba	191 010	4 607	–	7 070	202 687	199 222	4 561	–	7 149	210 933
Saskatchewan	x	180 306	x	4 173	260 909	x	178 364	x	4 244	274 792
Alberta	–	x	x	x	197 665	–	x	x	x	205 425
British Columbia	255 693	4 449	225 477	32 617	518 236	232 346	4 566	245 419	34 158	516 488
Yukon	x	–	–	x	11 574	x	–	–	x	38 176
Northwest Territories	x	–	–	–	125 580	x	–	–	–	x
Total	2 039 125	473 749	478 032	251 569	3 262 475	2 087 429	460 511	511 824	246 607	3 306 371

Sources: Natural Resources Canada; Statistics Canada.
– Nil; x Confidential.
1 Includes establishments primarily engaged in providing contract drilling and other services to petroleum and natural gas industries.
Note: This table no longer includes data for the petroleum and natural gas industries.

TABLE 41. CANADA, SOURCE OF ORES HOISTED OR REMOVED FROM SELECTED TYPES OF MINES, 1994-96

Mines	1994 Underground	1994 Open-Pit	1994 Total	1995 Underground	1995 Open-Pit	1995 Total	1996 Underground	1996 Open-Pit	1996 Total
					(000 tonnes)				
METALS									
Gold	17 124	4 164	21 288	16 740	8 381	25 120	18 684	12 217	30 901
Silver-lead-zinc	7 444	–	7 444	8 133	2 162	10 295	7 617	4 039	11 656
Uranium	1 220	536	1 756	1 283	81	1 364	922	411	1 333
Iron	636	95 088	95 723	845	94 693	95 538	731	95 052	95 783
Nickel-copper-zinc	22 453	70 198	92 651	26 839	86 421	113 260	28 851	69 820	98 671
Miscellaneous metals	899	13 988	14 887	924	13 975	14 899	1 073	13 586	14 659
Subtotal metals	49 775	183 973	233 748	54 762	205 713	260 475	57 879	195 124	253 003
NONMETALS									
Asbestos	1 320	10 597	11 916	1 525	10 185	11 710	1 544	9 793	11 337
Gypsum	1 137	7 807	8 944	916	7 708	8 623	933	7 651	8 584
Potash	38 846	–	38 846	40 196	–	40 196	34 103	–	34 103
Rock salt	11 758	–	11 758	9 854	–	9 854	11 226	–	11 226
Miscellaneous nonmetals	267	2 134	2 401	231	1 981	2 212	219	2 023	2 241
Subtotal nonmetals	53 327	20 537	73 864	52 722	19 874	72 596	48 025	19 466	67 491
MINERAL FUELS									
Coal	5 329	91 287	96 616	5 318	92 389	97 707	4 593	95 766	100 359
Total metals, nonmetals and mineral fuels	108 433	295 797	404 229	112 802	317 976	430 778	110 497	310 357	420 853
Percentage	27	73	100	32	68	100	26	74	100

Sources: Natural Resources Canada; Statistics Canada.
– Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 42. CANADA, SOURCE OF MATERIAL HOISTED OR REMOVED FROM SELECTED TYPES OF MINES, 1996

	Underground		Open-Pit			
	Ore	Waste	Ore	Waste	Over-burden	Tailings
			(000 tonnes)			
METALS						
Gold	18 684	3 723	12 217	36 979	3 711	29 540
Silver-lead-zinc	7 617	316	4 039	21 175	3 449	10 021
Uranium	922	355	411	3 529	–	1 363
Iron	731	–	95 052	6 672	9 303	54 893
Nickel-copper-zinc	28 851	1 874	69 820	72 141	3 414	93 248
Miscellaneous metals	1 073	2	13 586	13 389	–	11 789
Subtotal metals	57 879	6 269	195 124	153 885	19 877	200 854
NONMETALS						
Asbestos	1 544	–	9 793	13 255	–	5 589
Gypsum	933	97	7 651	2 813	2 278	324
Potash	34 103	365	–	–	–	19 256
Rock salt	11 226	434	–	–	–	371
Miscellaneous nonmetals	218	35	2 023	1 999	255	937
Subtotal nonmetals	48 025	932	19 466	18 068	2 534	26 478
MINERAL FUELS						
Coal	4 593	. .	95 766	. .	. .	. .
Total metals, nonmetals and mineral fuels	110 497	7 201	310 356	171 953	22 411	227 332

Sources: Natural Resources Canada; Statistics Canada.
– Nil; . . Not available.
Note: Numbers may not add to totals due to rounding.

TABLE 43. CANADA, ORE MINED AND ROCK QUARRIED IN THE MINING INDUSTRY, 1991-96

	1991	1992	1993	1994	1995	1996
			(000 tonnes)			
METALS						
Gold	22 851	20 842	19 285	21 288	25 120	30 901
Silver-lead-zinc	12 572	13 306	8 001	7 444	10 295	11 656
Uranium	2 308	1 562	1 663	1 756	1 364	1 333
Iron	98 179	81 524	78 741	95 723	95 538	95 783
Nickel-copper-zinc	118 554	117 601	116 277	92 651	113 259	98 671
Miscellaneous metals	16 890	13 325	12 496	14 887	14 899	14 659
Subtotal metals	271 354	248 160	236 464	233 748	260 475	253 003
NONMETALS						
Asbestos	13 698	13 837	12 140	11 916	11 710	11 337
Gypsum	7 203	7 957	8 472	8 944	8 623	8 584
Potash	32 578	32 152	30 811	38 846	40 196	34 103
Rock salt	11 035	9 966	10 350	11 758	9 854	11 226
Miscellaneous nonmetals	2 010	–	2 371	2 401	2 212	2 241
Subtotal nonmetals	66 524	63 912	64 143	73 864	72 596	67 491
STRUCTURAL MATERIALS						
Stone, all kinds quarried	102 986	104 549	105 998	110 411	120 660	112 420
MINERAL FUELS						
Coal	90 290	81 415	87 603	96 616	97 707	100 359
Total ore mined and rock quarried	531 154	498 036	494 208	514 639	551 438	533 273

Sources: Natural Resources Canada; Statistics Canada.
– Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 44. CANADA, ORE MINED AND ROCK QUARRIED IN THE MINING INDUSTRY, 1961-96

Year	Metals	Industrial Minerals[1]	Coal	Total
		(million tonnes)		
1961	90.1	96.7	. .	186.8
1962	103.6	103.8	. .	207.4
1963	112.7	120.4	. .	233.1
1964	128.0	134.1	. .	262.1
1965	151.0	146.5	. .	297.5
1966	147.6	171.8	. .	319.4
1967	169.1	177.5	. .	346.6
1968	186.9	172.7	. .	359.6
1969	172.0	178.8	. .	350.8
1970	213.0	179.1	. .	392.1
1971	211.5	185.8	. .	397.3
1972	206.0	189.7	. .	395.7
1973	274.9	162.6	. .	437.4
1974	278.7	178.8	. .	457.5
1975	264.2	158.7	. .	422.9
1976	296.5	167.1	. .	463.6
1977	299.5	205.2	33.8	538.5
1978	248.1	205.5	36.3	489.9
1979	274.8	200.1	39.8	514.6
1980	290.1	193.5	43.9	527.5
1981	301.5	172.5	48.2	522.2
1982	238.4	121.2	53.0	412.5
1983	219.0	137.0	54.8	410.8
1984	246.4	167.8	71.2	485.4
1985	245.0	171.9	76.7	493.6
1986	256.3	179.1	72.7	508.2
1987	266.2	197.5	77.5	541.1
1988	282.1	210.3	89.3	581.6
1989	283.8	209.4	87.7	580.9
1990	280.6	195.4	89.5	565.4
1991	271.4	166.4	90.3	528.0
1992	248.2	169.2	81.4	498.8
1993	236.5	167.9	87.6	458.4
1994	233.7	184.3	96.6	514.6
1995	260.5	193.3	97.7	551.4
1996	253.0	179.9	100.4	533.3

Sources: Natural Resources Canada; Statistics Canada.
. . Not available.
[1] Includes nonmetallic mineral mining and all stone quarried, including stone used to make cement and lime. From 1979 onwards, coverage includes miscellaneous nonmetal mines previously excluded.
Note: Numbers may not add to totals due to rounding.

TABLE 45. CANADA, CRUDE MINERALS TRANSPORTED BY CANADIAN RAILWAYS, 1995-97

	1995	1996	1997
		(000 tonnes)	
METALLIC MINERALS			
Iron ores and concentrates	38 660	37 381	38 790
Alumina and bauxite	4 683	3 661	5 301
Nickel and nickel-copper ores and concentrates	2 955	3 499	3 221
Zinc ores and concentrates	1 435	1 265	1 154
Copper ores and concentrates	1 007	1 057	991
Lead ores and concentrates	186	148	105
Metallic ores and concentrates, n.e.s.	219	338	360
Subtotal	49 144	47 349	49 922
NONMETALLIC MINERALS			
Potash (KCl)	13 025	12 246	14 205
Gypsum	3 351	5 297	5 384
Sulphur, n.e.s.	4 657	5 210	5 704
Sulphur, liquid	1 742	1 623	1 654
Salt, rock	1 721	1 847	1 889
Limestone, n.e.s.	1 273	1 302	1 446
Phosphate rock	987	1 023	1 046
Sodium carbonate	376	311	402
Nepheline syenite	310	312	317
Sodium sulphate	252	264	218
Limestone, industrial	190	144	164
Sand, industrial	175	151	147
Clay	102	102	116
Nonmetallic minerals, n.e.s.	118	117	112
Salt, n.e.s.	86	81	50
Limestone, agricultural	114	134	145
Stone, n.e.s.	45	76	82
Abrasives, natural	4	6	6
Barite	3	2	1
Silica	2	3	4
Asbestos	1	1	2
Sand, n.e.s.	. . .	4	1
Peat and other mosses	–	–	5
Subtotal	28 535	30 255	33 100
MINERAL FUELS			
Coal, bituminous	38 516	39 470	32 123
Coal, lignite	917	989	1 562
Natural gas and other crude bituminous substances	43	72	63
Oil, crude	1	3	3
Coal, n.e.s.	1 288	–	1
Subtotal	40 765	40 533	33 754
Total crude minerals	118 444	118 137	116 777
Total revenue freight[1] moved by Canadian railways	253 685	252 081	268 088
Crude minerals as a percentage of total revenue freight	46.7	46.9	43.6

Source: Statistics Canada.
– Nil; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified.
1 Revenue freight refers to a local or interline shipment from which earnings accrue to a carrier.
Note: Numbers may not add to totals due to rounding.

TABLE 46. CANADA, FABRICATED MINERAL PRODUCTS TRANSPORTED BY CANADIAN RAILWAYS, 1995-97

	1995	1996	1997
		(000 tonnes)	
METALLIC MINERAL PRODUCTS			
Ferrous mineral products			
Iron and steel scrap	1 405	1 554	3 593
Sheets and strips, steel	1 243	1 091	1 297
Bars and rods, steel	741	858	819
Ingots, blooms, billets, slabs, iron and steel	715	691	682
Pipes and tubes, iron and steel	321	377	402
Structural shapes and sheet piling, iron and steel	241	191	307
Plates, steel	361	378	282
Rails and railway track material	169	197	70
Castings and forgings, iron and steel	58	61	78
Pig iron	28	21	20
Ferroalloys	15	19	19
Other primary iron and steel	1	3	8
Wire, iron or steel	. . .	2	. . .
Subtotal ferrous mineral products	5 299	5 444	7 576
Nonferrous mineral products			
Aluminum and aluminum alloy fabricated material, n.e.s.	955	881	947
Zinc and alloys	498	539	533
Aluminum paste, powder, pigs, ingots, shot	340	294	426
Copper and alloys, n.e.s.	396	402	361
Other nonferrous base metals and alloys	412	401	458
Lead and alloys	137	144	112
Slag, dross, etc.	120	46	140
Nonferrous metal scrap	50	35	5 637
Copper matte and precipitates	85	19	9
Subtotal nonferrous mineral products	2 994	2 761	8 624
Total metallic mineral products	8 293	8 205	16 200
NONMETALLIC MINERAL PRODUCTS			
Fertilizers and fertilizer materials, n.e.s.	2 754	2 772	2 976
Sulphuric acid	2 571	2 339	2 358
Portland cement, standard	2 025	1 840	1 973
Lime, hydrated and quick	167	203	175
Cement and concrete basic products, n.e.s.	170	261	274
Nonmetallic mineral basic products, n.e.s.	121	132	187
Natural stone basic products, chiefly structural	93	126	124
Asbestos and asbestos-cement basic products	15	20	17
Gypsum basic products, n.e.s.	116	146	167
Dolomite and magnesite, calcined	35	25	27
Refractories, n.e.s.	4	–	1
Fire brick and similar shapes	4	7	5
Plaster	2	–	–
Glass basic products	4	–	1
Bricks and tiles, clay	2	3	1
Total nonmetallic mineral products	8 082	7 873	8 287
MINERAL FUEL PRODUCTS			
Refined and manufactured gases, fuel type	2 129	1 381	1 132
Fuel oil, n.e.s.	487	492	404
Diesel fuel	600	763	745
Gasoline	660	975	1 421
Other petroleum and coal products	626	639	769
Coke, n.e.s.	360	373	381
Petroleum coke	288	318	429
Lubricating oils and greases	223	258	364
Asphalts and road oils	300	370	406
Total mineral fuel products	5 674	5 569	6 052
Total fabricated mineral products	22 049	21 647	30 539
Total revenue freight[1] moved by Canadian railways	253 685	252 081	252 081
Fabricated mineral products as a percentage of total revenue freight	8.7	8.6	12.1

Source: Statistics Canada.
– Nil; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified.
[1] Revenue freight refers to a local or interline shipment from which earnings accrue to a carrier.
Note: Numbers may not add to totals due to rounding.

TABLE 47. CANADA, CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS TRANSPORTED BY CANADIAN RAILWAYS, 1960-97

Year	Total Revenue Freight[1]	Total Crude Minerals	Total Fabricated Mineral Products	Total Crude and Fabricated Minerals	Crude and Fabricated Minerals as a Percentage of Revenue Freight
		(million tonnes)			(%)
1960	142.8	57.1	14.5	71.6	50.1
1961	138.9	54.1	13.6	67.7	48.7
1962	146.0	60.3	13.8	74.1	50.8
1963	154.6	62.9	15.5	78.4	50.6
1964	180.0	74.6	15.9	90.5	50.3
1965	186.2	80.9	17.3	98.2	52.7
1966	194.5	80.6	17.8	94.8	50.6
1967	190.0	81.2	17.7	98.9	52.1
1968	195.4	86.7	18.8	105.5	54.0
1969	189.0	81.9	27.6	109.5	57.9
1970	211.6	97.5	28.4	125.9	59.5
1971	214.5	95.6	27.4	123.0	57.3
1972	215.8	89.4	27.6	117.0	54.2
1973	241.2	113.1	29.1	142.2	59.0
1974	246.3	115.3	30.9	146.2	59.4
1975	226.0	110.6	26.6	137.2	60.7
1976	238.5	116.6	25.5	142.1	59.6
1977	247.2	121.1	25.7	146.8	59.4
1978	238.8	107.7	26.2	133.9	56.1
1979	257.9	127.2	26.6	153.8	59.6
1980	254.4	124.8	24.6	149.4	58.7
1981	246.6	120.7	26.4	147.1	59.7
1982	212.5	95.7	21.0	116.7	54.9
1983	222.8	95.3	22.7	118.0	53.0
1984	254.6	121.1	25.1	146.2	57.4
1985	250.6	125.2	24.3	149.5	59.7
1986	249.8	121.2	23.0	144.2	57.7
1987	261.4	122.2	22.7	144.9	55.4
1988	269.4	134.9	23.2	158.1	58.7
1989	247.0	122.3	23.1	145.4	58.9
1990	226.3	112.1	20.1	132.2	58.4
1991	233.3	114.4	19.1	133.5	57.2
1992	226.2	102.8	20.9	123.7	54.7
1993	224.0	100.8	21.4	122.3	54.6
1994	253.6	112.6	21.4	134.0	52.8
1995	253.7	118.4	22.0	140.5	55.4
1996	252.1	118.1	21.6	139.8	55.5
1997	268.1	116.8	30.5	147.3	55.0

Source: Statistics Canada.
1 Revenue freight refers to a local or interline shipment from which earnings accrue to a carrier.

TABLE 48. CANADA, CRUDE MINERALS LOADED AND UNLOADED IN COASTWISE SHIPPING, 1997

	Loaded					Unloaded				
	Atlantic	St. Lawrence	Great Lakes	Pacific	Total	Atlantic	St. Lawrence	Great Lakes	Pacific	Total
					(tonnes)					
METALLIC MINERALS										
Iron ore and concentrates	–	5 711 824	–	–	5 711 824	–	1 410 142	4 301 682	–	5 711 824
Aluminum ores and concentrates	–	20 741	–	–	20 741	–	–	20 741	–	20 741
Lead and zinc ores and concentrates	–	–	–	–	–	–	–	–	–	–
Other ores and concentrates	–	2 655 110	271 082	–	2 926 192	–	2 583 989	342 203	–	2 926 192
Total metallic minerals	–	8 387 675	271 082	–	8 658 757	–	3 994 131	4 664 626	–	8 658 757
NONMETALLIC MINERALS										
Salt	1 026 749	–	2 021 442	–	3 048 191	266 166	1 451 810	1 330 215	–	3 048 191
Limestone	395 391	23 454	1 770 417	647 215	2 836 477	23 454	395 391	1 770 417	647 215	2 836 477
Sand and gravel	76 775	–	296 424	1 019 921	1 393 120	76 775	44 073	252 351	1 019 921	1 393 120
Gypsum	778 538	–	–	73 135	851 673	162 420	348 364	267 754	73 135	851 673
Potash	–	–	67 299	–	67 299	–	28 972	38 327	–	67 299
Sulphur	–	–	–	8 294	8 294	–	–	–	8 294	8 294
Other mineral products (including clays, coal briquettes, greases and asphalt)	255 855	184 205	2 347 905	104 212	2 892 177	211 489	522 244	2 054 232	104 212	2 892 177
Total nonmetallic minerals	2 533 308	207 659	6 503 487	1 852 777	11 097 231	740 304	2 790 854	5 713 298	1 852 777	11 097 231
MINERAL FUELS										
Coal and coke	–	–	517 720	–	517 720	–	58 894	458 826	–	517 720
Crude petroleum	24 137	–	–	–	24 137	11 122	13 015	–	–	24 137
Total mineral fuels	24 137	–	517 720	–	541 857	11 122	71 909	458 826	–	541 857
Total crude minerals	2 557 445	8 595 334	7 292 289	1 852 777	20 297 845	751 426	6 856 894	10 836 748	1 852 777	20 297 845
Total all commodities[1]	6 033 382	11 570 816	16 998 131	12 037 507	46 639 836	4 886 480	15 597 541	14 118 309	12 037 507	46 639 837
Crude minerals as a percentage of all products	42.4	74.3	42.9	15.4	43.5	15.4	44.0	76.8	15.4	43.5

Source: Statistics Canada.
– Nil.
1 Includes metallic minerals, nonmetallic minerals and mineral fuels, along with all other cargo loaded and unloaded in coastwise shipping.
Note: Numbers may not add to totals due to rounding.

TABLE 49. CANADA, FABRICATED MINERAL PRODUCTS LOADED AND UNLOADED IN COASTWISE SHIPPING, 1997

	Loaded					Unloaded				
	Atlantic	St. Lawrence	Great Lakes	Pacific	Total	Atlantic	St. Lawrence	Great Lakes	Pacific	Total
	(tonnes)									
METALLIC MINERAL PRODUCTS										
Iron, steel and alloys	327	3 007	–	–	3 334	513	2 820	–	–	3 333
Aluminum and aluminum products	–	236 403	–	–	236 403	–	236 403	–	–	236 403
Other base-metal products	1 650	3 485	–	–	5 135	3 358	1 778	–	–	5 136
Total metallic mineral products	1 977	242 895	–	–	244 872	3 871	241 001	–	–	244 872
NONMETALLIC MINERAL PRODUCTS										
Cement and related products	4 110	77 517	469 898	53 846	605 371	4 110	–	547 415	53 846	605 371
Other fabricated nonmetallic minerals, n.e.s.	122 939	50 636	47 149	130 958	351 682	36 326	127 606	56 793	130 958	351 683
Total nonmetallic mineral products	127 049	128 153	517 047	184 804	957 053	40 436	127 606	604 208	184 804	957 054
MINERAL FUEL PRODUCTS										
Gasoline	950 392	488 587	217 214	212 033	1 868 226	1 094 891	297 823	263 478	212 033	1 868 225
Petroleum coke	–	–	6 055	–	6 055	–	–	6 055	–	6 055
Other fabricated mineral fuels, n.e.s.	1 882 725	1 252 483	1 090 831	158 981	4 385 020	1 931 860	1 349 008	945 170	158 981	4 385 019
Total mineral fuel products	2 833 117	1 741 070	1 314 100	371 014	6 259 301	3 026 751	1 646 831	1 214 703	371 014	6 259 299
Total fabricated mineral products	2 962 143	2 112 118	1 831 147	555 818	7 461 226	3 071 058	2 015 438	1 818 911	555 818	7 461 225
Total all commodities[1]	6 033 382	11 570 816	16 998 131	12 037 507	46 639 836	4 886 480	15 597 541	14 118 309	12 037 507	46 639 837
Fabricated mineral products as a percentage of all commodities	49.1	18.3	10.8	4.6	16.0	62.8	12.9	12.9	4.6	16.0

Source: Statistics Canada.
– Nil; n.e.s. Not elsewhere specified.
[1] Includes metallic mineral products, nonmetallic mineral products and mineral fuel products, along with all other cargo loaded and unloaded in coastwise shipping.
Note: Numbers may not add to totals due to rounding.

TABLE 50. CANADA, CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS LOADED AT CANADIAN PORTS IN COASTWISE SHIPPING, 1960-97

Year	Total All Commodities[1]	Total Crude Minerals	Total Fabricated Minerals	Crude and Fabricated Minerals as a Percentage of All Products
		(000 tonnes)		(%)
1960	37 058	8 786	8 229	45.9
1961	41 861	9 527	8 857	43.9
1962	39 763	8 361	9 768	45.6
1963	40 328	7 998	9 942	44.5
1964	47 171	8 522	11 194	41.8
1965	48 200	9 183	11 766	43.5
1966	55 122	10 155	12 653	41.4
1967	49 799	11 509	12 207	47.6
1968	50 921	13 698	13 245	52.9
1969	51 890	12 746	14 181	51.9
1970	57 301	14 415	14 818	51.0
1971	55 128	14 783	15 374	54.7
1972	55 326	14 197	15 290	53.3
1973	55 314	16 573	15 615	58.2
1974	53 633	11 723	16 575	52.8
1975	54 373	15 687	17 510	61.1
1976	53 882	15 924	16 208	59.6
1977	58 309	18 131	17 435	61.0
1978	60 668	18 318	16 619	57.6
1979	79 950	22 130	17 486	49.6
1980	82 761	22 947	17 134	48.4
1981	71 271	17 849	16 669	48.4
1982	65 881	16 473	13 214	45.1
1983	67 598	21 248	12 025	49.2
1984	68 698	22 798	11 909	50.5
1985	61 717	19 867	10 291	48.9
1986	60 506	19 901	10 264	49.9
1987	67 572	20 969	11 118	47.5
1988	69 974	23 325	11 676	50.0
1989	62 016	22 963	11 825	56.1
1990	60 360	22 430	16 096	63.8
1991	58 430	19 624	10 370	51.3
1992	52 262	22 125	9 325	60.2
1993	49 976	21 088	8 168	58.5
1994	51 534	21 221	9 510	59.6
1995	50 370	20 626	8 825	58.5
1996	48 829	22 393	7 634	61.5
1997	46 639	20 298	7 461	59.5

Source: Statistics Canada.
[1] Includes metallic mineral products, nonmetallic mineral products and mineral fuel products, along with all other cargo loaded and unloaded in coastwise shipping.

TABLE 51. CANADA, CRUDE MINERALS LOADED AND UNLOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE,[1] 1995-97

	1995		1996		1997	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
			(tonnes)			
METALLIC MINERALS						
Iron ore and concentrates	30 881 324	6 669 449	29 536 169	7 788 880	32 875 256	8 033 932
Aluminum ores and concentrates	31 220	2 446 881	28 567	2 601 680	81 200	2 771 756
Lead and zinc ores and concentrates	783 640	415 720	849 908	519 920	924 026	452 714
Copper and nickel ores and concentrates	939 185	188 953	812 201	248 066	751 546	218 313
Other ores and base-metal products	1 565 330	400 049	1 584 910	384 193	1 329 312	332 979
Total metallic minerals	34 000 [illegible]	10 131 062	32 821 758	11 522 761	35 961 336	11 809 884
NONMETALLIC MINERALS						
Limestone	2 815 336	3 802 487	2 398 173	3 474 739	2 854 250	3 098 455
Sand and gravel	787 134	1 419 895	1 073 325	1 203 973	1 537 271	793 208
Gypsum	5 857 472	271 811	5 577 586	314 929	6 157 611	457 371
Salt	2 412 987	1 127 848	3 504 958	1 082 158	3 493 441	1 084 288
Sulphur	4 879 719	176	5 191 848	19 824	5 512 308	534
Potash	6 508 979	20	5 798 119	22 101	6 117 530	29
Other mineral products (including clays, coal briquettes, greases and asphalt)	3 225 573	2 630 985	1 981 952	3 006 900	4 925 802	2 805 177
Total nonmetallic minerals	26 487 176	9 253 232	25 511 958	9 123 625	30 386 410	8 247 037
MINERAL FUELS						
Coal and coke	33 984 947	10 396 728	34 176 597	12 633 941	36 549 641	15 081 228
Crude petroleum	5 630 238	25 653 074	4 441 733	26 174 392	8 073 655	30 384 239
Other mineral fuels	–	–	–	–	–	–
Total mineral fuels	39 615 185	36 049 802	38 618 330	38 808 333	44 623 296	45 445 467
Total crude mineral products	100 103 062	55 434 088	96 952 044	59 454 717	110 983 044	65 502 198
Total all commodities[1]	176 539 783	83 175 680	174 308 180	85 791 564	187 718 502	94 538 098
Crude minerals as a percentage of all commodities	56.7	66.6	55.6	69.3	59.1	69.3

Source: Statistics Canada.
– Nil.
[1] Includes metallic minerals, nonmetallic minerals and mineral fuels, along with all other cargo loaded and unloaded at Canadian ports.
Note: Numbers may not add to totals due to rounding.

TABLE 52. CANADA, FABRICATED MINERAL PRODUCTS LOADED AND UNLOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE,[1] 1995-97

	1995		1996		1997	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
			(tonnes)			
METALLIC MINERAL PRODUCTS						
Iron, steel and alloys	1 648 013	2 738 600	1 357 807	2 719 410	1 451 001	3 638 383
Nonferrous metals, n.e.s.	1 020 791	3 598 281	1 063 039	3 891 720	1 047 468	3 914 078
Total metallic mineral products	2 668 804	6 337 881	2 420 846	6 611 130	2 498 467	7 552 461
NONMETALLIC MINERAL PRODUCTS						
Cement and related products	2 859 091	202 185	3 154 880	198 940	2 739 896	375 340
Other nonmetallic minerals, n.e.s.	1 548 101	1 527 491	2 250 694	1 489 196	2 142 140	1 747 880
Total nonmetallic mineral products	4 407 192	1 729 676	5 405 574	1 688 136	4 882 036	2 123 220
MINERAL FUEL PRODUCTS						
Gasoline	3 340 924	1 537 104	4 124 542	1 740 356	4 114 237	1 958 798
Fuel oil	3 424 489	2 246 242	3 626 419	2 088 515	3 955 310	2 635 536
Coke, petroleum and coal products	434 171	1 033 607	321 018	1 087 586	573 595	1 008 136
Other mineral fuels, n.e.s.	2 070 255	1 253 686	2 681 191	818 088	2 443 171	1 363 522
Total mineral fuel products	9 269 839	6 070 619	10 753 170	5 712 535	11 086 313	[illegible]
Total fabricated mineral products	16 345 835	14 138 176	18 579 590	13 988 801	18 466 816	16 642 670
Total all commodities[1]	176 539 783	83 175 680	174 308 180	85 791 564	187 718 502	94 538 098
Fabricated mineral products as a percentage of all commodities	9.3	17.0	10.7	16.3	9.8	17.6

Source: Statistics Canada.
n.e.s. Not elsewhere specified.
[1] Includes metallic mineral products, nonmetallic mineral products and mineral fuel products, along with all other cargo loaded and unloaded at Canadian ports.
Note: Numbers may not add to totals due to rounding.

TABLE 53. CANADA, CRUDE MINERALS AND FABRICATED MINERAL PRODUCTS LOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE, 1960-97

Year	Total All Commodities[1]	Total Crude Minerals	Total Fabricated Minerals	Crude and Fabricated Minerals as a Percentage of All Products
		(000 tonnes)		(%)
1960	45 872	24 671	2 039	58.2
1961	48 771	23 241	2 133	52.0
1962	54 676	30 446	2 296	59.9
1963	62 031	32 214	2 503	56.0
1964	75 760	42 087	2 602	59.0
1965	74 521	41 338	2 746	59.2
1966	76 192	41 374	3 350	58.7
1967	72 598	42 704	3 701	63.9
1968	78 663	48 680	2 960	65.6
1969	70 432	42 442	3 456	65.2
1970	95 807	55 849	4 965	63.5
1971	95 887	53 245	5 022	60.8
1972	98 988	51 912	9 091	61.6
1973	112 434	64 195	10 103	66.1
1974	106 110	64 093	9 041	68.9
1975	102 444	61 970	7 495	67.8
1976	114 815	71 527	6 108	67.6
1977	119 770	70 257	5 979	63.7
1978	116 522	62 291	7 556	59.9
1979	134 639	79 685	8 901	65.8
1980	138 161	67 898	11 770	57.7
1981	145 445	83 007	9 022	63.3
1982	125 282	65 594	7 115	58.0
1983	129 490	67 152	6 197	56.6
1984	145 322	82 752	7 986	62.4
1985	143 421	83 878	10 814	66.0
1986	144 561	84 720	8 303	64.3
1987	158 994	86 085	10 488	60.7
1988	171 064	98 934	12 227	65.0
1989	159 069	90 807	13 624	65.7
1990	159 039	88 504	15 107	65.1
1991	168 030	90 165	16 138	63.3
1992	153 786	78 600	14 643	60.6
1993	152 162	81 418	16 723	64.5
1994	169 463	94 423	15 725	65.0
1995	176 540	100 103	16 346	66.0
1996	174 306	96 952	18 580	66.3
1997	187 717	110 983	18 467	69.0

Source: Statistics Canada.
[1] Includes metallic mineral products, nonmetallic mineral products and mineral fuel products, along with all other cargo loaded and unloaded at Canadian ports.

TABLE 54. CANADA, CAPITAL AND REPAIR EXPENDITURES BY SELECTED INDUSTRIAL SECTOR, 1997-99

		Capital Expenditures			Repair Expenditures[1]		
		Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total
		($ millions)					
Agriculture and related service industries	1997	1 463.2	2 849.1	4 312.3	595.8	1 966.5	2 562.3
	1998p	1 462.0	2 747.5	4 209.4	. .	. .	. .
	1999i	1 468.7	2 786.9	4 255.5	. .	. .	. .
Fishing and trapping	1997	43.4	57.1	100.5	33.4	126.8	160.2
	1998p	44.4	57.3	101.7	. .	. .	. .
	1999i	45.2	57.9	103.1	. .	. .	. .
Logging and forestry	1997	121.4	184.5	305.8	36.9	291.8	328.7
	1998p	122.2	164.4	286.7	. .	. .	. .
	1999i	159.1	140.3	299.4	. .	. .	. .
Mining[2]	1997	17 367.2	3 001.1	20 368.4	569.6	2 388.8	2 958.4
	1998p	14 213.0	3 013.0	17 226.0	. .	. .	. .
	1999i	13 358.5	2 457.7	15 816.2	. .	. .	. .
Manufacturing	1997	3 587.3	15 753.9	19 341.2	1 017.5	7 630.9	8 648.4
	1998p	2 578.0	16 886.5	19 464.5	. .	. .	. .
	1999i	2 550.9	16 937.5	19 488.4	. .	. .	. .
Construction	1997	301.3	1 870.6	2 171.9	63.8	1 050.8	1 114.6
	1998p	318.8	1 984.1	2 302.9	. .	. .	. .
	1999i	335.2	2 084.0	2 419.2	. .	. .	. .
Transportation and storage	1997	3 138.7	3 978.7	7 117.4	1 346.4	3 503.0	4 849.4
	1998p	5 007.3	4 592.3	9 599.6	. .	. .	. .
	1999i	5 191.8	4 611.6	9 803.4	. .	. .	. .
Communications and other utilities	1997	6 434.8	7 657.5	14 092.3	1 329.0	2 659.7	3 988.7
	1998p	7 427.7	7 858.7	15 286.5	. .	. .	. .
	1999i	8 070.8	8 354.9	16 425.7	. .	. .	. .
Wholesale and retail trade	1997	1 652.7	4 250.3	5 903.0	362.5	1 048.8	1 411.3
	1998p	2 072.3	4 369.5	6 441.8	. .	. .	. .
	1999i	2 208.5	4 079.3	6 287.8	. .	. .	. .
Housing	1997	37 406.6	–	37 406.6	5 100.0	–	5 100.0
	1998p	38 319.7	–	38 319.7	. .	. .	. .
	1999i	39 252.4	–	39 252.4	. .	. .	. .
Total[3]	1997	89 679.8	67 769.7	157 449.5	15 170.4	22 849.8	38 020.3
	1998p	89 952.2	71 374.8	161 327.1	. .	. .	. .
	1999i	91 953.6	69 623.9	161 577.5	. .	. .	. .
Mining as a percentage of total	1997	19.3	4.4	12.9	3.8	10.5	7.8
	1998p	15.8	4.2	10.7	. .	. .	. .
	1999i	14.5	3.5	9.8	. .	. .	. .

Source: Statistics Canada.
– Nil; . . Not available; i Intentions; p Preliminary actual.
1 Repair data are not available for 1998 and 1999. 2 Includes mines, quarries and oil wells. 3 Includes finance, real estate, insurance, commercial services, institutions and government departments.
Notes: Numbers may not add to totals due to rounding. Capital and repair expenditures are based on the 1980 Standard Industrial Classification.

TABLE 55. CANADA, CAPITAL AND REPAIR EXPENDITURES IN THE MINERAL INDUSTRY[1] BY PROVINCE AND TERRITORY, 1997-99

Province/ Territory		Capital Expenditures			Repair Expenditures[2]		
		Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total
				($ millions)			
Newfoundland	1997	952.3	85.9	1 038.2	6.3	162.6	168.9
	1998p	895.2	92.8	988.0	. .	. .	. .
	1999i	1 460.5	65.9	1 526.4	. .	. .	. .
Nova Scotia	1997	100.9	30.2	131.0	0.4	22.5	22.9
	1998p	975.8	40.1	1 016.0	. .	. .	. .
	1999i	994.0	37.8	1 031.8	. .	. .	. .
New Brunswick	1997	x	x	94.8	x	x	x
	1998p	x	x	101.7	. .	. .	. .
	1999i	x	x	x	. .	. .	. .
Quebec	1997	506.7	160.1	666.8	32.1	314.5	346.6
	1998p	454.3	96.5	550.9	. .	. .	. .
	1999i	391.6	89.3	480.9	. .	. .	. .
Ontario	1997	397.6	213.7	611.3	68.0	401.0	469.0
	1998p	355.6	171.5	527.2	. .	. .	. .
	1999i	367.5	187.4	554.8	. .	. .	. .
Manitoba	1997	149.7	40.4	190.1	28.9	38.1	67.1
	1998p	125.8	26.5	152.4	. .	. .	. .
	1999i	123.2	27.7	150.9	. .	. .	. .
Saskatchewan	1997	2 393.8	266.7	2 660.5	63.6	229.9	293.6
	1998p	1 164.8	297.1	1 462.0	. .	. .	. .
	1999i	765.2	317.9	1 083.0	. .	. .	. .
Alberta	1997	10 659.1	1 857.0	12 516.0	309.7	704.6	1 014.2
	1998p	8 478.0	1 975.5	10 453.5	. .	. .	. .
	1999i	7 757.9	1 550.1	9 308.0	. .	. .	. .
British Columbia	1997	1 774.7	302.9	2 077.6	46.8	381.9	428.7
	1998p	1 328.0	206.7	1 534.7	. .	. .	. .
	1999i	1 251.5	142.2	1 393.7	. .	. .	. .
Yukon	1997	x	x	19.8	x	x	x
	1998p	x	x	14.6	. .	. .	. .
	1999i	x	x	x	. .	. .	. .
Northwest Territories	1997	354.9	7.3	362.2	2.6	49.9	52.5
	1998p	355.6	69.6	425.2	. .	. .	. .
	1999i	189.4	11.8	201.2	. .	. .	. .
Total Canada	1997	17 367.2	3 001.1	20 368.4	569.6	2 388.8	2 958.4
	1998p	14 213.0	3 013.0	17 226.0	. .	. .	. .
	1999i	13 358.5	2 457.7	15 816.2	. .	. .	. .

Source: Statistics Canada.
. . Not available; p Preliminary actual; i Intentions; x Confidential.
1 Includes mines, quarries and oil wells. 2 Repair data are not available for 1998 and 1999.
Notes: Numbers may not add to totals due to rounding. Capital and repair expenditures are based on the 1980 Standard Industrial Classification.

TABLE 56. CANADA, CAPITAL AND REPAIR[1] EXPENDITURES IN THE MINERAL EXTRACTION AND MINERAL MANUFACTURING INDUSTRIES, 1997-99

	1997			1998p	1999i
	Capital	Repair	Total	Capital	Capital
			($ millions)		
MINERAL EXTRACTION					
Metal mines					
Gold	1 017.9	308.3	1 326.2	512.3	516.7
Copper and copper-zinc	335.3	183.7	518.9	178.7	185.9
Nickel-copper	446.6	x	x	298.5	273.7
Silver-lead-zinc	140.4	98.1	238.5	141.9	89.8
Uranium	205.6	x	x	x	x
Iron	x	271.1	x	197.6	170.5
Other metal mines	29.3	x	x	23.6	22.6
Total	2 377.6	1 166.4	3 544.0	1 555.0	1 464.7
Nonmetal mines					
Asbestos	x	x	x	x	x
Peat	15.0	8.5	23.5	15.9	15.6
Gypsum	14.1	x	x	38.6	34.7
Potash	108.6	104.6	213.2	104.1	136.4
Salt	x	35.8	x	x	x
Other nonmetal mines	315.5	9.1	324.6	370.4	151.0
Coal	224.0	340.0	564.0	216.1	175.6
Total	782.6	560.8	1 343.3	827.2	607.8
Quarries and sand pits	118.5	87.3	205.8	128.6	87.7
Crude petroleum and natural gas	16 152.7	824.1	16 976.8	13 893.7	13 174.3
Service industries incidental to mineral extraction	936.9	319.8	1 256.7	821.5	481.7
Total mineral industry	20 368.4	2 958.4	23 326.8	17 226.0	15 816.2
MINERAL MANUFACTURING					
Primary metal industries					
Primary steel	711.5	935.0	1 646.5	592.1	528.0
Steel pipe and tube mills	138.8	72.9	211.7	86.8	50.8
Iron foundries	52.4	86.0	138.4	64.7	133.3
Smelting and refining	970.9	614.7	1 585.6	809.4	1 469.4
Aluminum rolling, casting and extruding	103.8	94.4	198.2	112.4	152.1
Copper and copper alloy, rolling, casting and extruding	11.7	16.6	28.2	20.6	20.9
Metal rolling, casting and extruding	191.4	45.8	237.2	173.5	130.6
Total	2 180.5	1 865.4	4 045.8	1 859.5	2 485.2
Nonmetallic mineral products					
Clay products	20.6	12.0	32.6	30.1	45.5
Cement	95.0	88.4	183.4	244.4	184.4
Concrete products	25.4	13.8	39.2	25.0	31.9
Ready-mix concrete	104.1	84.8	188.9	162.6	278.7
Glass and glass products	98.4	26.1	124.4	120.6	79.7
Abrasives	6.8	6.8	13.6	5.4	6.5
Lime	8.0	8.3	16.3	18.4	11.8
Other nonmetallic mineral products	46.7	42.5	89.2	77.3	103.5
Total	405.2	282.5	687.6	683.9	742.1

TABLE 56 (cont'd)

	1997 Capital	1997 Repair	1997 Total	1998p Capital	1999i Capital
			($ millions)		
MINERAL MANUFACTURING (cont'd)					
Metal-fabricating industries					
Power boiler and heat exchanger	15.7	6.2	21.9	12.9	11.7
Fabricated structural metal	36.2	36.4	72.7	35.6	53.3
Ornamental and architectural metal	33.1	13.5	46.7	38.5	23.1
Metal stamping, pressing and coating	212.1	101.3	313.4	161.5	212.4
Wire and wire products	91.4	41.1	132.5	91.3	97.2
Hardware, tool and cutlery	141.3	41.8	183.1	154.3	98.2
Heating equipment	31.5	18.0	49.5	36.7	40.1
Machine shops	94.5	24.7	119.2	81.0	50.0
Miscellaneous metal fabricating	132.8	29.6	162.4	134.6	98.0
Total	788.7	312.7	1 101.4	746.5	684.0
Petroleum and coal products					
Refined petroleum products	368.0	237.6	605.6	503.6	777.4
Other petroleum products	57.5	10.5	68.0	42.9	28.5
Total	425.5	248.0	673.5	546.5	805.9
Total mineral manufacturing industries	3 799.9	2 708.6	6 508.3	3 836.4	4 717.2
Total mineral and mineral manufacturing industries	24 168.3	5 667.0	29 835.1	21 062.4	20 533.4

Source: Statistics Canada.
i Intentions; p Preliminary actual; x Confidential.
1 Repair data are not available for 1998 and 1999.
Notes: Numbers may not add to totals due to rounding. Capital and repair expenditures are based on the 1980 Standard Industrial Classification.

Definitions and Valuation: Mineral Production, Shipments and Trade

Mineral Statistics

The publication of statistics on the mineral production of Canada was instituted by the Geological and Natural History Survey of Canada as early as 1886. The Department of Mines carried out this compilation through the early part of the twentieth century. Subsequent to the transfer of this work, Statistics Canada published the data for the period 1921 to 1978. In January 1979, the responsibility for Canadian non-fuel mineral statistics was transferred from Statistics Canada to the Department of Energy, Mines and Resources (now Natural Resources Canada). Statistics Canada retains responsibility for fuels and mineral manufacturing statistics (i.e., cement, lime, clay, and smelting and refining).

The construction of new metallurgical plants and the development of new types of ore have resulted in changes in methods of compilation over the period but, in general, the following principles have been followed.

For nonmetallic minerals such as asbestos, talc, barite, etc., and for structural materials such as stone, cement, etc., the mine or quarry shipments are taken to represent production. Usually there is little difference between actual output and mine shipments, and it is more convenient and practical to measure the product at the latter point. Values are computed on the f.o.b. shipping point basis and they represent, therefore, the amounts actually received by the producers. Values are adjusted to exclude the costs of containers, taxes, duties, sales discounts and outward-bound transportation.

Production data for certain simple metallic ores such as iron ore, uranium, etc., are compiled in a similar manner, that is, products shipped from a specific shipping point at f.o.b. values. For some metals this is not practical and an attempt is made to measure output in terms of recoverable metals in concentrates shipped, which are then valued at current market prices.

The value of metallic mineral production calculated in this manner does not coincide with the amounts actually received by the producers.

Details of the Methods Used in Computing the Mineral Production of Canada

Metallic Mineral Production

Antimony
Production includes recoverable antimony in concentrates shipped. The value is calculated using the yearly average New York dealer price.

Bismuth
Production includes recoverable bismuth in concentrates shipped. The value is calculated using the yearly average New York dealer price.

Cadmium
Cadmium is associated with zinc. Production includes the recoverable content of cadmium in the zinc-lead concentrates shipped, valued at the yearly average New York dealer price.

Calcium
Output figures represent calcium metal plus the calcium content of alloys from Canadian sources valued at the average yearly price of metal crowns.

Cesium
Production figures represent the cesium oxide content of pollucite ore shipped. The value is as reported by the producer.

Cobalt
Production includes recoverable cobalt in concentrates shipped. The value is calculated using the average yearly cathode dealer spot prices.

Copper
Production includes recoverable copper in concentrates shipped. The value is calculated using a combination of the Commodities Exchange, Inc. (COMEX) first position price and the average London Metal Exchange Grade A Settlement price.

Germanium
Production includes germanium contained in concentrates shipped with values as reported by the shipper.

Gold
Production includes gold in crude bullion obtained directly from placer workings and lode gold mines, and recoverable gold in all types of ores and concentrates shipped. The value is calculated using the average final price as established by bullion dealers in London.

Ilmenite
Production includes shipments of direct shipping grade ore at Canada's sole shipper's reported value.

Indium
Production includes quantities recovered in the smelting of silver-lead-zinc ores from Canadian sources. The output is valued by the shipper.

Iron Ore
Production figures represent product shipments (pellets, concentrates, ores) at the values shown by the shippers. Production from steel plant waste oxides is excluded.

Iron (Remelt)
This is sometimes called pig iron or Sorel iron. It is a co-product in the smelting of ilmenite ores. Quantity and value figures are those reported by the producer.

Lead
Production includes recoverable lead in concentrates shipped. The value is computed at the average producer price for the year.

Lithium
Production figures represent the lithium oxide content of spodumene and amblygonite ore shipped. The value is as reported by the producer.

Magnesium
Output figures represent magnesium metal, plus the magnesium content of alloys from Canadian sources. Values are compiled using the average yearly price of primary ingots.

Molybdenum
Production figures are the molybdenum content of the oxides, ferromolybdenum and sulphides shipped; the value is that shown by the shipper.

Nickel
Production includes recoverable nickel in concentrates shipped. The value is calculated using an assessment price based on London Metal Exchange prices.

Niobium (Columbium)
Production includes niobium (columbium) contained in concentrates shipped with values as reported by the shipper.

Platinum Group Metals (PGM)
Production figures for iridium, palladium, platinum, ruthenium and rhodium include the PGM content in nickel-copper matte shipped by Canadian smelters, and the PGM content in concentrates exported. Quantities are valued using average New York dealer prices or London Metal Exchange prices depending on the metal.

Rhenium
Production figures reflect the content of concentrates shipped. Values are those reported by the shipper.

Rubidium
Production figures include the content of concentrates shipped. Values are as reported by the shipper.

Selenium
Production includes selenium produced as a refinery by-product from Canadian sources and recoverable selenium contained in concentrates exported. The quantities are valued at the average New York dealer price for the year.

Silver
Production includes silver in crude bullion obtained directly from placer workings and lode gold mines, and recoverable silver in all types of ores and concentrates shipped. The value is calculated using the average of Toronto quotations for the year.

Tantalum
Production comprises the tantalum pentoxide content of concentrates shipped as valued by the shipper.

Tellurium
Production includes tellurium produced as a refinery by-product from Canadian sources and recoverable tellurium contained in concentrates exported. The quantities are valued at the average producers' price for the year.

Tin
Production figures comprise recoverable tin in tin concentrates shipped. The value is based on the average New York dealer price for the year.

Uranium
Producers of uranium precipitates or concentrates report the metal content (U) of the shipments and the value received by the shipper. Refinery conversion facility by-products are not included.

Zinc
Production comprises recoverable zinc in concentrates shipped. The value is calculated using the average London Metal Exchange price for the year.

Nonmetallic Mineral Production

Owing to the fact that it is difficult to obtain figures of the actual production of nonmetallic minerals in Canada, and since the first actual measurement is when the product is sold, plant shipments have been taken to represent production in all cases.

Barite
Production is the shipments of the various grades at the selling value, f.o.b. shipping points.

Chrysotile (Asbestos)
Production figures represent shipments of the various grades at the total selling value, f.o.b. shipping points, less the value of containers.

Diamonds
Production is the number of carats produced at the mine. Value is reported by the producer.

Gemstones
Production is the tonnage of crude and rough cut amethyst, jade and labradorite shipped at its selling value, f.o.b. shipping points.

Graphite
Production is the shipments of various grades from the mill at its selling value, f.o.b. the mill, less container costs.

Gypsum
Production is taken as the tonnage of crude gypsum and anhydrite shipped from quarries or mines in lump, crushed or fine-ground forms. The value is that reported by the operators. (Note: Gypsum used in the manufacture of cement in Canadian cement plants is excluded.)

Magnesitic Dolomite (Magnesite)
Production is the tonnage of crude material sold by primary producers, plus the tonnage of calcined or dead-burned material sold or consumed by primary producers. The value is that reported by the producers.

Marl
Production is producers' shipments from the plant. Values, f.o.b. plant, are reported by the producer.

Mica
Production is recorded as shipments from plants dressing new mica, and exported shipments directly from the mines. The value of shipments is taken as reported by operators.

Nepheline Syenite
Production of crude and ground nepheline syenite is the amount of the various grades shipped at the total selling value, f.o.b. works, less container costs.

Peat
Production comprises crude peat shipped to Canadian non-producers as fuel or for export, baled peat shipped, and the peat content of mixed products shipped. Value is the sales value, f.o.b. works, less the cost of containers.

Potash
Production represents producers' shipments of various grades from the plant and is measured as the K_2O equivalent. The value of shipments, f.o.b. plant, is reported by the producers.

Potassium Sulphate
Production is producers' shipments from the plant. Values, f.o.b. plant, are reported by the producer.

Pumice
Production is producers' shipments from the plant. Values, f.o.b. plant, are reported by the producer.

Quartz (Silica)
Production represents the tonnage of crude or pulverized quartz, quartzite, pure silica sand, or other natural silica material shipped for sale, plus the tonnage of any of these materials consumed by producers. The value is taken as reported by producers.

Salt
Production is taken as the tonnage of various grades of dry salt shipped by primary producers, plus the salt content of brine used by producers for industrial (chemical) purposes. The value is that reported by producers.

Serpentine
Production represents producers' shipments of various grades valued f.o.b. plant, as reported by the producer.

Soapstone, Talc, Pyrophyllite
Production comprises crude, ground or sawn soapstone shipments; crude, milled or refined talc shipments; and crude or ground pyrophyllite shipments. All shipments are f.o.b. the mill or plant and are valued by the shipper.

Sodium Sulphate
Production is the tonnage of crude or refined natural sodium sulphate shipped at its selling value, f.o.b. shipping points. The figures exclude the sodium sulphate produced as a by-product of paper or rayon manufacturing.

Sulphur in Smelter Gas
Prior to final metal recovery, sulphide concentrates are smelted or roasted and the resultant gases may be used to produce marketable sulphur, sulphur dioxide or sulphuric acid. Production is considered as the sulphur content of sulphuric acid made, sulphur dioxide marketed and sulphur shipped. This sulphur is valued at the average price for sulphur sold in acid. Production is shown by province of origin of concentrates.

Sulphur, Elemental
In the western provinces, sour natural gas is processed to remove hydrogen sulphide, which is further reduced to yellow elemental sulphur. Sulphur recovered from the refining of Canadian crude petroleum is also included. Production is shown by province of origin of material and values are as reported by the shippers.

Titanium Dioxide

Ilmenite ore is smelted at Sorel, Quebec, to produce a slag containing titanium dioxide. Production is the titanium dioxide content of slag valued by the producer.

Tremolite

Production is shipments of various grades at the selling values, f.o.b. shipping point, less the value of containers.

Zeolite

Production is shipments from the plant. Values are f.o.b. plant, as reported by the producer.

Fuels

Coal

Production figures are equal to shipments from the mine/plant plus "own" consumption as valued by shippers, f.o.b. mine/plant.

Natural Gas

Production figures represent sales of natural gas from dry gas fields after field uses, losses and reinjection, but before inventory changes. Values are as reported by the producers.

Natural Gas By-Products

Production figures for propanes, butanes, etc., represent the quantity that is available for market. It is the quantity produced by gas processing plants after processing and reprocessing plant uses, losses and shrinkage. Values are selling value, f.o.b. shipping points.

Oil, Crude and Equivalent

Production figures represent the production of crude oil from both conventional and non-conventional sources after field use, losses and reinjection. Values are those reported by shippers, f.o.b. well head or plant.

Structural Materials

Cement

Production comprises shipments of Portland and masonry cements, exported clinker, and transfers to other corporate divisions for use in other manufacturing processes. Values are f.o.b. plant, as reported by the shipper.

Clay Products

Production represents shipments of brick and other clay products made from domestic clays, and shipments of unmanufactured clays (bentonite, diatomite) at the total selling value, f.o.b. works, as reported by the operators. Data relating to clay products manufactured from imported clays are not included.

Lime

Production represents the tonnage of hydrated and quicklime shipped (sold by the producer) together with the tonnage of these limes produced and consumed by the producers of chemicals and allied products. The values are as reported by the producer.

Sand and Gravel

Production represents shipments of natural gravel, sand and crushed gravel at the values reported by operators of sand and gravel pits or dredges.

Stone

Production represents quarry shipments of crude or undressed stone, crushed stone and dressed stone, if the latter is prepared by the quarry operators at values as reported by the operators. The figures include data for both private and public or municipally owned properties. Production figures do not include dressed stone prepared from imported stone or prepared from domestic stone in works not at the quarries.

To avoid duplication in computing a total value for Canadian mineral production, the quantity and value of stone consumed in the manufacture of lime, cement and clay products are not included in the totals for stone production. These particular data are recorded separately and are published in conjunction with data for the lime, cement and clay industries.

VALUATION OF TRADE DATA

(Note: The following has been extracted from Statistics Canada catalogue no. 65-003.)

For Customs purposes, imports are recorded at values established according to the provisions of the *Customs Act* which, since January 1, 1985, reflects valuation methods based on the General Agreement on Tariffs and Trade (GATT) Valuation Code System. It generally requires that the value for duty of imported goods be equivalent to the transaction value or the price actually paid.

To determine the transaction value of imported goods, all transportation and associated costs arising in respect of the goods being appraised prior to and at the place of direct shipment to Canada are to be added to the price of the goods. Therefore, Canadian imports are valued f.o.b. (free on board), place of direct shipment to Canada. The value excludes freight and insurance costs in bringing the goods to Canada from the point of direct shipment.

To countries other than the United States, exports are, in principle, valued or recorded at the values declared on export documents, which usually reflect the transaction value, i.e., actual selling price, or in the case of a non-arm's-length transaction, the transfer price used for company accounting purposes. Canadian exports to overseas countries are valued at f.o.b. port of exit, including domestic freight charges to that point, but net of discounts and allowances. As of January 1990, Canadian exports to the United States are valued f.o.b. point of exit from Canada. Prior to 1990, they were valued f.o.b. place of lading net of freight charges, discounts and allowances.